Dispersion tailoring of a silicon strip waveguide employing Titania-Alumina thin-film coating

We numerically demonstrate dispersion tailoring of a silicon strip waveguide employing Titania-Alumina thin-film coating using a finite-difference mode solver. The proposed structure exhibits spectrally-flattened near-zero anomalous dispersion within the telecom wavelength range. We also numerically predict the wavelength conversion efficiency for degenerate four-wave mixing, and obtain a 3 dB bandwidth of 80 nm.
1.142 μm GaAsBi/GaAs Quantum Well Lasers Grown by Molecular Beam Epitaxy

As a promising new class of near-infrared light emitters, GaAsBi laser diodes (LDs) are considered to have a high energy efficiency and an insensitive temperature dependence of the band gap. In this paper, we realize the longest ever reported lasing wavelength up to 1.142 μm at room temperature in GaAsBi0.058/GaAs quantum well LDs grown by molecular beam epitaxy. The output power is up to 127 mW at 300 K under pulsed mode. We also demonstrate continuous wave mode operation up to 273 K for the first time. The temperature coefficient of the GaAsBi/GaAs LD is 0.26 nm/K in the temperature range of 77-350 K, lower than that of both InGaAsP/InP and InGaAs/GaAs LDs. The characteristic temperature is extracted to be 139 K in the temperature range of 77-225 K and decreases to 79 K at 225-350 K.

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.
Full-vectorial propagation model and modified effective mode area of four-wave mixing in straight waveguides

We derive from Maxwell’s equations full-vectorial nonlinear propagation equations of four-wave mixing valid in straight semiconductor-on-insulator waveguides. Special attention is given to the resulting effective mode area, which takes a convenient form known from studies in photonic crystal fibers, but has not been introduced in the context of integrated waveguides. We show that the difference between our full-vectorial effective mode area and the scalar equivalent often referred to in the literature may lead to mistakes when evaluating the nonlinear refractive index and optimizing designs of new waveguides. We verify the results of our derivation by comparing it to experimental measurements in a silicon-on-insulator waveguide, taking tolerances on fabrication parameters into account. (C) 2017 Optical Society of America

General information

State: Published
Organisations: Department of Photonics Engineering, Fiber Optics, Devices and Non-linear Effects, Centre of Excellence for Silicon Photonics for Optical Communications, Nanophotonic Devices, High-Speed Optical Communication, Diode Lasers and LED Systems, National University of Defense Technology, Technical University of Denmark
Authors: Guo, K. (Ekstern), Friis, S. M. M. (Intern), Christensen, J. B. (Intern), Christensen, E. N. (Intern), Shi, X. (Ekstern), Ding, Y. (Intern), Ou, H. (Intern), Rottwitt, K. (Intern)
Pages: 3670-3673
Publication date: 2017
Main Research Area: Technical/natural sciences
High coincidence-to-accidental ratio continuous-wave photon-pair generation in a grating-coupled silicon strip waveguide: Letters

We demonstrate a very high coincidence-to-accidental ratio of 673 using continuous-wave photon-pair generation in a silicon strip waveguide through spontaneous four-wave mixing. This result is obtained by employing on-chip photonic-crystal-based grating couplers for both low-loss fiber-to-chip coupling and on-chip suppression of generated spontaneous Raman scattering noise. We measure a minimum heralded second-order correlation of $g^{(2)}(0) = 0.12$, demonstrating that our source operates in the single-photon regime with low noise. (C) 2017 The Japan Society of Applied Physics

General information
State: Published
Organisations: Department of Photonics Engineering, Fiber Optics, Devices and Non-linear Effects, Centre of Excellence for Silicon Photonics for Optical Communications, High-Speed Optical Communication, Nanophotonic Devices, Diode Lasers and LED Systems, National University of Defense Technology
Authors: Guo, K. (Ekstern), Christensen, E. N. (Intern), Christensen, J. B. (Intern), Koefoed, J. G. (Intern), Bacco, D. (Intern), Ding, Y. (Intern), Ou, H. (Intern), Rottwitt, K. (Intern)
Number of pages: 5
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Main Research Area: Technical/natural sciences

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BFI (2015): BFI-level 1
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Scopus rating (2014): SJR 1.248 SNIP 1.166 CiteScore 1.91
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.474 SNIP 1.369 CiteScore 1.8
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.808 SNIP 1.458 CiteScore 2.27
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.796 SNIP 1.473 CiteScore 2.42
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.501 SNIP 1.188
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.975 SNIP 1.18
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SNIP 1.158
Scopus rating (2007): SNIP 1.153
Localized Surface Plasmon on 6H SiC with Ag Nanoparticles

Silver (Ag) nanoparticles (NPs) were deposited on the surface of bulk Nitrogen-Boron co-doped 6H silicon carbide (SiC), and the Ag NPs were observed to induce localized surface plasmons (LSP) resonances on the SiC substrate, which was expected to improve the internal quantum efficiency (IQE) of the emissions of the donor-acceptor pairs of the SiC substrate. Roomtemperature measurements of photoluminescence (PL), transmittance and time-resolved photoluminescence (TRPL) were applied to characterize the LSP resonances. Through the finitedifference time-domain (FDTD) simulation of the LSP resonance of an Ag nanoparticle on the SiC substrate, it is predicted that when the diameter of the cross section on the xy plane of the Ag nanoparticle is greater than 225 nm, the LSP starts to enhance the PL intensity. With implementation of a 3rd order exponential decay fitting model to the TRPL results, it is found that the average minority carrier lifetime of the SiC substrate decreased.

General information
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Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Centre of Excellence for Silicon Photonics for Optical Communications
Authors: Wei, Y. (Intern), Fadil, A. (Intern), Ou, H. (Intern)
Pages: 634-637
Publication date: 2017
Main Research Area: Technical/natural sciences
A nano-patterning approach on silicon dioxide (SiO2) material, which could be used for the selective growth of III-V nanowires in photovoltaic applications, is demonstrated. In this process, a silicon (Si) stamp with nanopillar structures was first fabricated using electron-beam lithography (EBL) followed by a dry etching process. Afterwards, the Si stamp was employed in nanoimprint lithography (NIL) assisted with a dry etching process to produce nanoholes on the SiO2 layer. The demonstrated approach has advantages such as a high resolution in nanoscale by EBL and good reproducibility by NIL. In addition, high time efficiency can be realized by one-spot electron-beam exposure in the EBL process combined with NIL for mass production. Furthermore, the one-spot exposure enables the scalability of the nanostructures for different application requirements by tuning only the exposure dose. The size variation of the nanostructures resulting from exposure parameters in EBL, the pattern transfer during nanoimprint in NIL, and subsequent etching processes of SiO2 were also studied quantitatively. By this method, a hexagonal arranged hole array in SiO2 with a hole diameter ranging from 45 to 75 nm and a pitch of 600 nm was demonstrated on a four-inch wafer.
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 significant 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.

General information
State: Published
Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Center for Electron Nanoscopy, DTU Danchip, Centre of Excellence for Silicon Photonics for Optical Communications, Meijo University, Linköping University
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Main Research Area: Technical/natural sciences

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Volume: 7
Issue number: 9798
ISSN (Print): 2045-2322
Ratings:
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Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
A 2 x 2 imaging MIMO system based on LED Visible Light Communications employing space balanced coding and integrated PIN array reception

In this paper, we proposed a 2 x 2 imaging Multi-Input Multi-Output (MIMO)-Visible Light Communication (VLC) system by employing Space Balanced Coding (SBC) based on two RGB LEDs and integrated PIN array reception. We experimentally demonstrated 1.4-Gbit/s VLC transmission at a distance of 2.5 m. The proposed imaging system not only overcomes the limitation of bandwidth existing in LEDs, but also can reject the second-order nonlinearity distortion. It turned out to be very promising to use integrated antennas in the VLC system in the future. (C) 2016 Published by Elsevier B.V.
Antireflective SiC Surface Fabricated by Scalable Self-Assembled Nanopatterning

An approach for fabricating sub-wavelength antireflective structures on SiC material is demonstrated. A time-efficient scalable nanopatterning method by rapid thermal annealing of thin metal film is applied followed by a dry etching process. Size-dependent optical properties of the antireflective SiC structures have been investigated. It is found that the surface reflection of SiC in the visible spectral range is significantly suppressed by applying the antireflective structures. Meanwhile, optical transmission and absorption could be tuned by modifying the feature size of the structure. It is believed
that this effective fabrication method of antireflective structures could also be realized on other semiconductor materials or devices.

**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.
Comparison of wavelength conversion efficiency between silicon waveguide and microring resonator

Wavelength conversion based on degenerate four-wave mixing (FWM) was demonstrated and compared between silicon nanowire and microring resonator (MRR). 15 dB enhancement of conversion efficiency (CE) with relatively low input pump power (5 mW) was achieved experimentally in an MRR. The impacts of bus waveguide length and propagation loss were theoretically analyzed under the effect of nonlinear loss.

General information

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Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Nanophotonic Devices, High-Speed Optical Communication, Centre of Excellence for Silicon Photonics for Optical Communications, FOTON Laboratory, Huazhong University of Science and Technology
Authors: Xiong, M. (Intern), Ding, Y. (Intern), Ou, H. (Intern), Peucheret, C. (Ekstern), Zhang, X. (Ekstern)
Pages: 390-394
Publication date: 2016
Main Research Area: Technical/natural sciences

Publication information

Journal: Frontiers of Optoelectronics
Volume: 9
Issue number: 3
ISSN (Print): 2095-2759
Ratings:

Scopus rating (2016): SJR 0.315 SNIP 0.784 CiteScore 0.88
Web of Science (2016): Indexed yes
Electrically driven surface plasmon light-emitting diodes
We investigate device performance of GaN light-emitting diodes (LEDs) with a 30-nm p-GaN layer. The metallization used to separate the p-contact from plasmonic metals, reveals limitations on current spreading which reduces surface plasmonic enhancement.

General information
State: Published
Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Centre of Excellence for Silicon Photonics for Optical Communications, Tokyo University of Science
Authors: Fadil, A. (Intern), Ou, Y. (Intern), Iida, D. (Ekstern), Kopylov, O. (Intern), Ou, H. (Intern)
Number of pages: 1
Publication date: 2016
Event: Paper presented at 4th International workshop on LEDs and solar applications, Nagoya, Japan.
Main Research Area: Technical/natural sciences

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Invited talk at '4th International workshop on LEDs and solar applications', held at Meijo University, Nagoya, Japan, Mar.30-31, 2016
Source: PublicationPreSubmission
Source-ID: 123057207
Publication: Research - peer-review › Paper – Annual report year: 2016

Enhanced Emission Efficiency of Size-Controlled InGaN/GaN Green Nanopillar Light-Emitting Diodes
Nanopillar InGaN/GaN green light-emitting diode (LED) arrays were fabricated by self-assembled Au nanoparticles patterning and dry etching process. Structure size and density of the nanopillar arrays have been modified by varying the Au film thickness in the nanopatterning process. Fabricated nanopillar LEDs have been characterized by both room temperature and temperature-dependent photoluminescence measurements. A considerable internal quantum efficiency enhancement was achieved which is attributed to the suppressed quantum confined Stark effect derived from the internal strain relaxation. Meanwhile light extraction efficiency can also be enhanced significantly due to the increased light scattering at nanopillar sidewall. Compared to the planar LED, the nanopillar LED demonstrates the greatest external quantum efficiency enhancement by a factor of 4.08. It is believed that this nanopillar fabrication method can serve as an effective approach to increase the luminescence efficiency of LEDs.

General information
State: Published
Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Centre of Excellence for Silicon Photonics for Optical Communications, Tokyo University of Science
Authors: Ou, Y. (Intern), Iida, D. (Ekstern), Fadil, A. (Intern), Ou, H. (Intern)
Number of pages: 6
Publication date: 2016
Main Research Area: Technical/natural sciences
Enhancement of the Modulation Bandwidth for surface Plasmon coupled LEDs for Visible Light Communication

The modulation bandwidth of surface plasmon coupled GaN-based LEDs is increased by ~1.2 times to 434.5 MHz compared with normal LED by applying Ag nanoparticles. These findings will help for the industrialization of VLC system.

Fabrication and Evaluation of porous SiC

From the session: UV and Visible Optoelectronics (STu3R)

EMRS2016_iwasa_web0.docx.pdf

Bibliographical note


Source-ID: 126145845
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.

Formation of porous SiC and PL enhancement by Al2O3 passivation

Bibliographical note

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Source: PublicationPreSubmission
Source-ID: 123771101
Publication: Research - peer-review › Journal article – Annual report year: 2016

Electronic versions:
**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.

**General information**

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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
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Main Research Area: Technical/natural sciences

**Bibliographical note**

Invited talk at '4th International workshop on LEDs and solar applications', held at Meijo University, Nagoya, Japan, Mar.30-31, 2016

**Influence of near-field coupling from Ag surface plasmons on InGaN/GaN quantum-well photoluminescence**

We have investigated the borderline between photoluminescence quenching and enhancement of InGaN/GaN quantum-wells due to Ag nanoparticles and their surface plasmon modes. By embedding Ag nanoparticles inside nanohole structures on the p-type layer GaN, luminescence quenching is observed. Increasing the distance between the nanoparticles and quantum-wells has shown to enhance the emission. We have found that the nano-structure geometry of the metal-semiconductor interface in the near-field of the quantum-wells plays a crucial role in determining whether the emitter performance is enhanced or degraded.

**General information**

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Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Centre of Excellence for Silicon Photonics for Optical Communications, Huazhong University of Science and Technology, Meijo University
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- Web of Science (2017): Indexed Yes
- BFI (2016): BFI-level 1
- Scopus rating (2016): SJR 0.723 SNIP 1.14 CiteScore 2.61
- Web of Science (2016): Indexed yes
- BFI (2015): BFI-level 1
- Scopus rating (2015): SJR 0.787 SNIP 1.22 CiteScore 2.68
- BFI (2014): BFI-level 1
- Scopus rating (2014): SJR 0.811 SNIP 1.386 CiteScore 2.72
- Web of Science (2014): Indexed yes
- BFI (2013): BFI-level 1
Investigations of thin p-GaN light-emitting diodes

We investigate device performance of InGaN light-emitting diodes with a 30-nm p-GaN layer. The metallization used to separate the p-contact from plasmonic metals, reveals limitations on current spreading which reduces surface plasmonic enhancement.

General information
State: Published
Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Centre of Excellence for Silicon Photonics for Optical Communications, Tokyo University of Science
Authors: Fadil, A. (Intern), Ou, Y. (Intern), Iida, D. (Ekstern), Kopylov, O. (Intern), Ou, H. (Intern)
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ISBN (Print): 978-1-943580-11-8
Main Research Area: Technical/natural sciences
Conference: Conference on Lasers and Electro-Optics 2016, San Jose, California, United States, 05/06/2016 - 05/06/2016
DOIs: 10.1364/CLEO_SI.2016.STu3R.6

Bibliographical note
From the session: UV and Visible Optoelectronics (STu3R)
Investigations of thin p-GaN light-emitting diodes with surface plasmon compatible metallization

We investigate device performance of InGaN light-emitting diodes with a 30-nm p-GaN layer. The metallization used to separate the p-contact from plasmonic metals, reveals limitations on current spreading which reduces surface plasmonic enhancement.

General information
State: Published
Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, DTU Danchip, Others, Centre of Excellence for Silicon Photonics for Optical Communications, Tokyo University of Science
Authors: Fadil, A. (Intern), Ou, Y. (Intern), Iida, D. (Ekstern), Kopylov, O. (Intern), Ou, H. (Intern)
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Conference: Conference on Lasers and Electro-Optics 2016, San Jose, California, United States, 05/06/2016 - 05/06/2016
Light emitting diodes, Couplings, Plasmons, Metallization, Performance evaluation, Surface treatment
Source: FindIt
Source-ID: 2350000293
Publication: Research - peer-review › Article in proceedings – Annual report year: 2016

Linear all-optical signal processing using silicon micro-ring resonators

Silicon micro-ring resonators (MRRs) are compact and versatile devices whose periodic frequency response can be exploited for a wide range of applications. In this paper, we review our recent work on linear all-optical signal processing applications using silicon MRRs as passive filters. We focus on applications such as modulation format conversion, differential phase-shift keying (DPSK) demodulation, modulation speed enhancement of directly modulated lasers (DMLs), and monocycle pulse generation. The possibility to implement polarization diversity circuits, which reduce the polarization dependence of standard silicon MRRs, is illustrated on the particular example of DPSK demodulation.

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Organisations: Department of Photonics Engineering, Nanophotonic Devices, High-Speed Optical Communication, Centre of Excellence for Silicon Photonics for Optical Communications, Others, Diode Lasers and LED Systems, Department of Micro- and Nanotechnology, Huazhong University of Science and Technology, Chalmers University of Technology, FOTON Laboratory
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Localized Surface Plasmon on SiC with Ag Nanoparticles

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Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Centre of Excellence for Silicon Photonics for Optical Communications
Authors: Wei, Y. (Intern), Fadil, A. (Intern), Ou, H. (Intern)
Number of pages: 1
Publication date: 2016
Main Research Area: Technical/natural sciences
Electronic versions: C2203.pdf
Source: PublicationPreSubmission
Source-ID: 130604506
Publication: Research - peer-review › Paper – Annual report year: 2017

Luminescence enhancement of near ultraviolet light-emitting diodes
Nanopillars were applied on the p-GaN layer of the InGaN-based near ultraviolet epiwafer to improve the light extraction efficiency. A photoluminescence enhancement of 74 % is reported with a nanopillar height of around 105 nm.

General information
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Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, DTU Danchip
Authors: Lin, L. (Intern), Jensen, F. (Intern), Herstrøm, B. (Intern), Ou, H. (Intern)
Number of pages: 3
Publication date: 2016
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Publisher: Optical Society of America
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Main Research Area: Technical/natural sciences
DOIs: 10.1364/ACPC.2016.AS1F.4
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Source-ID: 128434575
Publication: Research - peer-review › Article in proceedings – Annual report year: 2017

On-chip mode division multiplexing technologies
Space division multiplexing (SDM) is currently widely investigated in order to provide enhanced capacity thanks to the utilization of space as a new degree of multiplexing freedom in both optical fiber communication and on-chip
interconnects. Basic components allowing the processing of spatial modes are critical for SDM applications. Here we present such building blocks implemented on the silicon-on-insulator (SOI) platform. These include fabrication tolerant wideband (de) multiplexers, ultra-compact mode converters and (de) multiplexers designed by topology optimization, and mode filters using one-dimensional (1D) photonic crystal silicon waveguides. We furthermore use the fabricated devices to demonstrate on-chip point-to-point mode division multiplexing transmission, and all-optical signal processing by mode-selective wavelength conversion. Finally, we report an efficient silicon photonic integrated circuit mode (de) multiplexer for few-mode fibers (FMFs).

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices, High-Speed Optical Communication, Centre of Excellence for Silicon Photonics for Optical Communications, Others, Diode Lasers and LED Systems, Department of Micro- and Nanotechnology, Huazhong University of Science and Technology, FOTON Laboratory
Authors: Ding, Y. (Intern), Frellsen, L. F. (Intern), Guan, X. (Intern), Xu, J. (Ekstern), Da Ros, F. (Intern), Ou, H. (Intern), Peucheret, C. (Ekstern), Frandsen, L. H. (Intern), Oxenløwe, L. K. (Intern), Yvind, K. (Intern)
Number of pages: 1
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Publication date: 2016

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ISSN: 0277-786X
Main Research Area: Technical/natural sciences
ENGINEERING, OPTICS, TELECOMMUNICATIONS, TAPERED DIRECTIONAL COUPLER, APODIZED GRATING COUPLER, SILICON WAVE-GUIDE, TOPOLOGY OPTIMIZATION, DESIGN, FIBER, DEMULTIPLEXER, FABRICATION, EFFICIENCY, CONVERSION, Mode division multiplexing, mode (de)multiplexer, mode converter, mode filter, topology optimization, photonic integrated circuit, Electronic, Optical and Magnetic Materials, Condensed Matter Physics, Computer Science Applications, Electrical and Electronic Engineering, Applied Mathematics, Integrated circuits, Light transmission, Multiplexing equipment, Optical communication, Optical fiber communication, Optical fiber fabrication, Optical fibers, Optical signal processing, Photonic devices, Photonic integration technology, Pulse analyzing circuits, Reconfigurable hardware, Shape optimization, Signal processing, Silicon, Silicon on insulator technology, Space division multiple access, Topology, Waveguide filters, Mode converter, Mode filters, Mode-division multiplexing, Photonic integrated circuits, Multiplexing, Optical communication devices, equipment and systems, Optical system design, Optical information, image formation and analysis, Optical harmonic generation, frequency conversion, parametric oscillation and amplification, Photonic bandgap materials, Spatial filters, zone plates, and polarizers, Optical fibre fabrication, cladding, splicing, joining, Integrated optics, Multiplexing and switching in optical communication, Metal-insulator-semiconductor structures, Optical materials, Optical coatings and filters, Optical, image and video signal processing, demultiplexing, integrated optics, optical design techniques, optical fibre communication, optical fibre fabrication, optical filters, optical information processing, optical wavelength conversion, optimisation, photonic crystals, silicon, silicon-on-insulator, few-mode fibers, silicon photonic integrated circuit mode demultiplexer, mode-selective wavelength conversion, all-optical signal processing, on-chip point-to-point mode division multiplexing transmission, 1D photonic crystal silicon waveguides, mode filters, ultracompact mode converters, fabrication tolerant wideband, silicon-on-insulator platform, spatial mode processing, on-chip interconnects, optical fiber communication, space division multiplexing, on-chip mode division multiplexing technologies, Si

Passivation of surface-nanostructured f-SiC and porous SiC
The further enhancement of photoluminescence from nanostructured fluorescent silicon carbide (f-SiC) and porous SiC by using atomic layer deposited (ALD) Al2O3 is studied in this paper.

General information
State: Published
Organisations: Fibers & Nonlinear Optics, Department of Photonics Engineering, Diode Lasers and LED Systems, Centre of Excellence for Silicon Photonics for Optical Communications, University of Erlangen-Nuremberg, Meijo University, Linköping University
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.

**General information**

State: Published
Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Centre of Excellence for Silicon Photonics for Optical Communications, Meijo University
Authors: Lu, W. (Intern), Iwasa, Y. (Ekstern), Ou, Y. (Intern), Kamiyama, S. (Ekstern), Petersen, P. M. (Intern), Ou, H. (Intern)
Number of pages: 2
Publication date: 2016

**Host publication information**

Title of host publication: Proceedings of CLEO: Science and Innovations 2016
Publisher: Optical Society of America OSA
Article number: SM1R.5
ISBN (Print): 978-1-943580-11-8
Main Research Area: Technical/natural sciences
Conference: Conference on Lasers and Electro-Optics 2016, San Jose, California, United States, 05/06/2016 - 05/06/2016

**Bibliographical note**

From the session: Photonic Nanostructures (SM1R)
Source: PublicationPreSubmission
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.

General information
State: Published
Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Centre of Excellence for Silicon Photonics for Optical Communications, Linköping University
Authors: Lu, W. (Intern), Ou, Y. (Intern), Jokubavicius, V. (Ekstern), Fadil, A. (Intern), Syväjärvi, M. (Ekstern), Petersen, P. M. (Intern), Ou, H. (Intern)
Number of pages: 4
Publication date: 2016
Main Research Area: Technical/natural sciences

Publication information
Journal: Physica Scripta
Volume: 91
Issue number: 7
ISSN (Print): 0031-8949
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.84
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 0.64
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 0.62
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 0.61
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 0.67
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 0.85
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
BFI (2008): BFI-level 1
Web of Science (2006): Indexed yes
Web of Science (2005): Indexed yes
Web of Science (2004): Indexed yes
Web of Science (2002): Indexed yes
Web of Science (2000): Indexed yes
Nano-textured, TiO2, Morphology, Optical, Passivation, ALD

A new type of white light-emitting diode light source basing on fluorescent SiC

Most of the commercial white light-emitting diode (LED) light sources are made from phosphor coated blue-emitting gallium nitride (GaN) chips. This type white LED light source always has tradeoff between luminous efficacy and color rendering index (CRI). Furthermore, yellow-emitting phosphor decays much faster than the semiconductor chip, so the white color will turn into bluish over the time. This paper will propose a new type white LED light source: using fluorescent silicon carbide (SiC) to take the place of phosphor. This new type LED has the following advantages: a) SiC is a wide bandgap semiconductor material, so it is stable; b) Fluorescent SiC has very wide emission spectrum, and it could generate white light with very high CRI; c) It is a better substrate than sapphire for the GaN growth in terms of lattice match and thermal conductivity. This paper will cover: the growth of fluorescent SiC, its optical characterization, nanostructuring of the SiC surface for extraction efficiency enhancement, and surface passivation for further efficiency enhancement.

General information
State: Published
Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, University of Erlangen-Nuremberg, Linköping University
Publication date: 2015

Application of Surface Plasmonics for Semiconductor Light-Emitting Diodes

This thesis addresses the lack of an efficient semiconductor light source at green emission colours. Considering InGaN based quantum-well (QW) light-emitters and light-emitting diodes (LEDs), various ways of applying surface plasmonics and nano-patterning to improve the efficiency, are investigated. By placing metallic thin films or nanoparticles (NPs) in the near-field of QW light-emitters, it is possible to improve their internal quantum efficiency (IQE) through the Purcell enhancement effect. It has been a general understanding that in order to achieve surface plasmon (SP) coupling with QWs and thereby IQE enhancement, the metal NP resonance should match the emission wavelength. This criterion is critically analysed, and based on the experimental findings, a more complicated relation is revealed. The requirements which must be satisfied to avoid optical suppression are presented. The SP-QW coupling does not necessarily lead to emission enhancement. The findings of this work show that the scattering and absorption properties of NPs play a crucial role in determining whether the implementation will improve or degrade the optical performance. By applying these principles, a novel design is presented to obtain light extraction efficiency (LEE) improvement through nano-patterning, and IQE improvement through SP-QW coupling. Considering the fabrication process aspect, dry-etching damage on the semiconductor light-emitters from the nano-patterning is also addressed. Different ion-damage treatment methods are presented to improve the efficiency of the QWs. Furthermore, a design for electrically driven LED device with SP compatibility is proposed, and requirements on p-type GaN layer thickness and current spreading properties are investigated experimentally.

General information
State: Published
Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Centre of Excellence for Silicon Photonics for Optical Communications
Authors: Fadil, A. (Intern), Ou, H. (Intern), Dam-Hansen, C. (Intern), Petersen, P. M. (Intern)
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.

Effective carrier sweepout in a silicon waveguide by a metal-semiconductor-metal structure

We demonstrate effective carrier depletion by metal-semiconductor-metal junctions for a silicon waveguide. Photo-generated carriers are efficiently swept out by applying bias voltages, and a shortest carrier lifetime of only 55 ps is demonstrated.
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.

General information

State: Published
Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Department of Micro- and Nanotechnology, Nanoprobes, Chinese Academy of Sciences, Lund University
Number of pages: 9
Publication date: 2015
Main Research Area: Technical/natural sciences

Publication information

Journal: Journal of Nanophotonics
Volume: 9
Article number: 093062
ISSN (Print): 1934-2608
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BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.47 SNIP 0.578 CiteScore 1.17
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.554 SNIP 0.618 CiteScore 1.34
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.562 SNIP 0.624 CiteScore 1.1
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.655 SNIP 0.686 CiteScore 1.2
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.821 SNIP 0.694 CiteScore 1.16
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.991 SNIP 1.209 CiteScore 1.59
ISI indexed (2011): ISI indexed no
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.008 SNIP 0.866
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.94 SNIP 1.03
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.613 SNIP 0.923
Original language: English
Light-emitting diodes, Gallium nitride, Nanopillar, Damage treatment
DOIs:
10.1117/1.JNP.9.093062
Source: PublicationPreSubmission
Source-ID: 114519688
Publication: Research - peer-review › Journal article – Annual report year: 2015
**Fabrication of InGaN/GaN nanopillar light-emitting diode arrays**

Nanopillar InGaN/GaN green light-emitting diode arrays were fabricated by using self-assembled nanopatterning and dry etching process. Both internal and external quantum efficiency were increased due to strain relaxation and enhanced light extraction.

**General information**

State: Published
Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems
Authors: Ou, Y. (Intern), Fadil, A. (Intern), Ou, H. (Intern)
Publication date: 2015
Main Research Area: Technical/natural sciences
Light-emitting diode, Nanopillar LED, QCSE

**Ge nanobelts with high compressive strain fabricated by secondary oxidation of self-assembly SiGe rings.**

Curl Ge nanobelts were fabricated by secondary oxidation of self-assembly SiGe rings, which were exfoliated from the SiGe stripes on the insulator. The Ge-rich SiGe stripes on insulator were formed by hololithography and modified Ge condensation processes of Si$_{0.82}$Ge$_{0.18}$ on SOI substrate. Ge nanobelts under a residual compressive strain of 2% were achieved, and the strain should be higher before partly releasing through bulge islands and breakage of the curled Ge nanobelts during the secondary oxidation process. The primary factor leading to compressive strain is thermal shrinkage of Ge nanobelts, which extrudes to Ge nanobelts in radial and tangent directions during the cooling process. This technique is promising for application in high-mobility Ge nano-scale transistors.

**General information**

State: Published
Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Xiamen University
Authors: Lu, W. (Intern), Li, C. (Ekstern), Lin, G. (Ekstern), Wang, C. (Ekstern), Huang, S. (Ekstern), Wei, J. (Ekstern), Lan, X. (Ekstern), Chen, S. (Ekstern), Ou, H. (Intern)
Number of pages: 6
Publication date: 2015
Main Research Area: Technical/natural sciences

**Internal quantum efficiency enhancement of GaInN/GaN quantum-well structures using Ag nanoparticles.**

We report internal quantum efficiency enhancement of thin p-GaN green quantumwell structure using self-assembled Ag nanoparticles. Temperature dependent photoluminescence measurements are conducted to determine the internal quantum efficiency. The impact of excitation power density on the enhancement factor is investigated. We obtain an internal quantum efficiency enhancement by a factor of 2.3 at 756 W/cm$^2$, and a factor of 8.1 at 1 W/cm$^2$. A Purcell enhancement up to a factor of 26 is estimated by fitting the experimental results to a theoretical model for the efficiency enhancement factor.

**General information**

State: Published
Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Meijo University
Luminescence enhancement of green InGaN/GaN nanopillar LEDs

General information
State: Published
Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Department of Micro- and Nanotechnology, Nanoprobes, Tokyo University of Technology
Number of pages: 2
Publication date: 2015
Main Research Area: Technical/natural sciences
Source: PublicationPreSubmission
Source-ID: 116616053
Publication: Research - peer-review › Journal article – Annual report year: 2015

Metal nanoparticles and patterned dielectric on InGaN/GaN LEDs: Combining plasmonic and light extraction enhancement.

General information
State: Published
Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Tokyo University of Technology
Authors: Fadil, A. (Intern), Ou, Y. (Intern), Iida, D. (Ekstern), Ou, H. (Intern)
Number of pages: 2
On-chip grating coupler array on the SOI platform for fan-in/fan-out of MCFs with low insertion loss and crosstalk

We report the design and fabrication of a compact multi-core fiber fan-in/fan-out using a grating coupler array on the SOI platform. The grating couplers are fully-etched, enabling the whole circuit to be fabricated in a single lithography and etching step. Thanks to the apodized design for the grating couplers and the introduction of an aluminum reflective mirror, a highest coupling efficiency of -3.8 dB with 3 dB coupling bandwidth of 48 nm and 1.5 dB bandwidth covering the whole C band, together with crosstalk lower than -32 dB are demonstrated. (C)2015 Optical Society of America
Photoluminescence enhancement in nano-textured fluorescent SiC passivated by atomic layer deposited Al2O3 films

General information
State: Published
Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, PicoQuant GmbH, Linköping University
Authors: Lu, W. (Intern), Ou, Y. (Intern), Jokubavicius, V. (Ekstern), Fadil, A. (Intern), Syväjärvi, M. (Ekstern), Buschmann, V. (Ekstern), Ruttinger, S. (Ekstern), Petersen, P. M. (Intern), Ou, H. (Intern)
Publication date: 2015
Main Research Area: Technical/natural sciences
Electronic versions:
We_P_18.pdf
DOIs:
10.1364/OE.23.003292
Source: FindIt
Source-ID: 274324041
Publication: Research - peer-review › Paper – Annual report year: 2015

Scalable nanostructuring on polymer by a SiC stamp: optical and wetting effects

General information
State: Published
Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems
Authors: Argyraki, A. (Intern), Lu, W. (Intern), Petersen, P. M. (Intern), Ou, H. (Intern)
Number of pages: 20
Publication date: 2015
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.

General information
State: Published
Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems
Authors: Argyraki, A. (Intern), Lu, W. (Intern), Petersen, P. M. (Intern), Ou, H. (Intern)
Number of pages: 6
Publication date: 2015

Host publication information
Title of host publication: Proceedings of SPIE
Volume: 9556
Publisher: SPIE - International Society for Optical Engineering

Series: Proceedings of SPIE, the International Society for Optical Engineering
Volume: 9556
ISSN: 0277-786X
Main Research Area: Technical/natural sciences
Conference: Nanoengineering: Fabrication, Properties, Optics, and Devices XII, San Diego, California, United States, 09/08/2015 - 09/08/2015
Scalable polymer nanostructuring, Optical effects, Wetting effects, Hot embossing, Galvanization, SiC
Electronic versions:
955607.pdf
DOIs:
10.1117/12.2186317

Bibliographical note
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Relations
Activities:
SPIE Optics and Photonics 2015
Source: PublicationPreSubmission
Source-ID: 115237499
Publication: Research - peer-review › Article in proceedings – Annual report year: 2015
Signal processing for on-chip space division multiplexing

Our recent results on the demonstration of on-chip mode-division multiplexing are reviewed, with special emphasis on nonlinear all-optical signal processing. Mode-selective parametric processes are demonstrated in a silicon-on-insulator waveguide.

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices, High-Speed Optical Communication, Diode Lasers and LED Systems, University of Rennes, Huazhong University of Science and Technology, Université de Rennes
Authors: Peucheret, C. (Ekstern), Ding, Y. (Intern), Xu, J. (Ekstern), Da Ros, F. (Intern), Ou, H. (Intern), Parini, A. (Ekstern)
Number of pages: 3
Publication date: 2015

Host publication information
Title of host publication: Signal Processing in Photonic Communications 2015
Publisher: Optical Society of America OSA
Article number: SpT2E.3
ISBN (Print): 978-1-55752-000-5
Main Research Area: Technical/natural sciences
Conference: Signal Processing in Photonic Communications 2015, Boston, Massachusetts, United States, 27/06/2015 - 27/06/2015
DOIs: 10.1364/SPPCOM.2015.SpT2E.3

Bibliographical note
From the session: Optical Signal Processing (SpT2E)
Source: PublicationPreSubmission
Source-ID: 115470816
Publication: Research - peer-review › Article in proceedings – Annual report year: 2015

Silicon carbide as platform for energy applications
Silicon carbide is emerging as a novel material for a range of energy and environmental technologies. Previously, silicon carbide was considered as a material mainly for transistor applications. We have initiated the use of silicon carbide material towards optoelectronics in general lighting and solar cells, and further pursue concepts in materials for thermoelectrics, biofuel cells and supercapacitor research proposals. In fact, there are a number of energy applications which can be based on the SiC materials.

- Fluorescent SiC for white LED in general lighting
- Cubic SiC for a highly efficient solar cell
- Cubic SiC for water splitting to generate hydrogen

Further on, we have the following concepts that could be explored:
- Thermoelectric SiC for electricity generation from heat
- Biofuels cells based on carbon electrodes on SiC
- Supercapacitors based on sintered SiC and carbon materials

Common to these SiC applications is the knowhow in growth technology based on SiC processes using the sublimation based method. We will give an overview of this new research field and outline the energy applications that could be addressed in a near future.

General information
State: Published
Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Linköping University, SINTEF, University of Erlangen-Nuremberg
Authors: Syväjärvi, M. (Ekstern), Jokubavičius, V. (Ekstern), Sun, J. (Ekstern), Liu, X. (Ekstern), Løvvik, O. M. (Ekstern), Ou, H. (Intern), Wellmann, P. (Ekstern)
Publication date: 2015
Main Research Area: Technical/natural sciences
Silicon carbide, Energy materials, Optoelectronics, Solar Cells, LEDs
Electronic versions:
AMWC_Abstract_Mikael.pdf
DOIs: 10.5185/amwc.2015.3438
Source: PublicationPreSubmission
Source-ID: 115471013
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2015
Transmittance enhancement in 6H-SiC with nanocone structures
Enhanced transmittance of 6H-SiC with nanocone structures were achieved by using self-assembled Au nanoparticles as etching mask. HF passivation process of nanocone structures was investigated to further improve the transmittance. The max transmittance of structured SiC is significantly improved by 10%.

General information
State: Published
Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems
Authors: Lu, W. (Intern), Ou, Y. (Intern), Ou, H. (Intern)
Publication date: 2015
Main Research Area: Technical/natural sciences
Nanocone, Transmittance, HF passivation
Electronic versions:
2015_EALED_D2.01.pdf
Source: PublicationPreSubmission
Source-ID: 106719333
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2015

Wavelength-conversion efficiency enhancement in nano-textured fluorescent 6H-SiC passivated by atomic layer deposited titanium oxide

General information
State: Published
Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Linköping University
Authors: Lu, W. (Intern), Ou, Y. (Intern), Jokubavicius, V. (Ekstern), Fadil, A. (Intern), Syväjärvi, M. (Ekstern), Petersen, P. M. (Intern), Ou, H. (Intern)
Publication date: 2015
Main Research Area: Technical/natural sciences
Electronic versions:
Source: PublicationPreSubmission
Source-ID: 115469834
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2015

Wavelength Conversion of a 640 Gbit/s DPSK Nyquist Channel Using a Low-Loss Silicon Nanowire
640 Gbit/s N-OTDM DPSK wavelength conversion is demonstrated in a Si-nanowire. All 64 tributaries are converted within an average power penalty of 1 dB at the FEC BER-limit3E-3. Only 22-fJ/bit switching energy is required.

General information
State: Published
Organisations: Department of Photonics Engineering, High-Speed Optical Communication, Nanophotonic Devices, Diode Lasers and LED Systems
Authors: Ji, H. (Intern), Hu, H. (Intern), Ding, Y. (Intern), Ou, H. (Intern), Yvind, K. (Intern), Oxenløwe, L. K. (Intern)
Number of pages: 3
Publication date: 2015

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Title of host publication: Proceedings of the Optical Fiber Communications Conference and Exhibition 2015
Publisher: IEEE
Article number: Tu2F.2
ISBN (Print): 978-1-55752-937-4
Main Research Area: Technical/natural sciences
Conference: Optical Fiber Communications Conference and Exposition 2015, Los Angeles, CA, United States, 22/03/2015 - 22/03/2015
Electronic versions:
3_OFC2015_JH_640_Nyquist_OTDM_DPSK_AOWC_in_Silicon_Nanowire.pdf
DOIs:
10.1364/OFC.2015.Tu2F.2
Source: PublicationPreSubmission
Source-ID: 110726037
Publication: Research - peer-review › Article in proceedings – Annual report year: 2015
Wavelength Conversion of DP-QPSK Signals in a Silicon Polarization Diversity Circuit
Multichannel wavelength conversion is experimentally demonstrated for high-speed 128 Gb/s dual-polarization quadrature phase-shift keying signals using four-wave mixing in a polarization diversity circuit with silicon nanowires as nonlinear elements. The wavelength conversion performance is investigated for both single-and three-channel input signals, showing quality factors well >9.8 dB (corresponding to bit-error-ratios better than 10⁻³) and with a negligible power penalty compared with the back-to-back case.

General information
State: Published
Organisations: Department of Photonics Engineering, High-Speed Optical Communication, Nanophotonic Devices, Diode Lasers and LED Systems, University of Sydney, Monash University, University of Rennes
Authors: Vukovic, D. (Intern), Schroeder, J. (Ekstern), Ding, Y. (Intern), Pelusi, M. D. (Ekstern), Du, L. B. (Ekstern), Ou, H. (Intern), Peucheret, C. (Intern)
Pages: 411-414
Publication date: 2015
Main Research Area: Technical/natural sciences

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Journal: IEEE PHOTONICS TECHNOLOGY LETTERS
Volume: 27
Issue number: 4
ISSN (Print): 1041-1135
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BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.52 SJR 1.018 SNIP 1.279
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.263 SNIP 1.327 CiteScore 2.62
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.461 SNIP 1.614 CiteScore 2.78
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.487 SNIP 1.547 CiteScore 2.95
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.623 SNIP 1.706 CiteScore 2.46
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.51 SNIP 2.012 CiteScore 2.48
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.474 SNIP 1.623
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.775 SNIP 1.804
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 2.081 SNIP 1.818
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 2.345 SNIP 1.566
Advances in wide bandgap SiC for optoelectronics

Silicon carbide (SiC) has played a key role in power electronics thanks to its unique physical properties like wide bandgap, high breakdown field, etc. During the past decade, SiC is also becoming more and more active in optoelectronics thanks to the progress in materials growth and nanofabrication. This paper will review the advances in fluorescent SiC for white light-emitting diodes, covering the poly-crystalline doped SiC source material growth, single crystalline epitaxy growth of fluorescent SiC, and nanofabrication of SiC to enhance the extraction efficiency for fluorescent SiC based white LEDs.

General information

State: Published
Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, University of Erlangen-Nuremberg, KTH - Royal Institute of Technology, Linköping University
Authors: Ou, H. (Intern), Ou, Y. (Intern), Argyraki, A. (Intern), Schimmel, S. (Ekstern), Kaiser, M. (Ekstern), Wellmann, P. (Ekstern), Linnarsson, M. K. (Ekstern), Jokubavicius, V. (Ekstern), Sun, J. (Ekstern), Liljedahl, R. (Ekstern), Syväjärvi, M. (Ekstern)
Number of pages: 16
Publication date: 2014
Main Research Area: Technical/natural sciences

Publication information

Journal: European Physical Journal B. Condensed Matter and Complex Systems
Volume: 87
Issue number: 3
Article number: 58
ISSN (Print): 1434-6028
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.452 SNIP 0.654 CiteScore 1.11
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.53 SNIP 0.744 CiteScore 1.13
We demonstrate a time-efficient and low-cost approach to fabricate Si$_3$N$_4$ coated nanodome structures in fluorescent SiC. Nanosphere lithography is used as the nanopatterning method and SiC nanodome structures with Si$_3$N$_4$ coating are formed via dry etching and thin film deposition process. By using this method, a significant broadband surface antireflection and a considerable omnidirectional luminescence enhancement are obtained. The experimental observations are then supported by numerical simulations. It is believed that our fabrication method will be well suitable for large-scale production in the future.
Fully-etched apodized fiber-to-chip grating coupler on the SOI platform with -0.78 dB coupling efficiency using photonic crystals and bonded Al mirror

We design and fabricate an ultra-high coupling efficiency fully-etched apodized grating coupler on the SOI platform using photonic crystals and bonded aluminum mirror. Ultra-high coupling efficiency of -0.78 dB with a 3 dB bandwidth of 74 nm are demonstrated.

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices, High-Speed Optical Communication, Diode Lasers and LED Systems, University of Rennes
Authors: Ding, Y. (Intern), Ou, H. (Intern), Peucheret, C. (Ekstern), Yvind, K. (Intern)
Number of pages: 3
Pages: 1-3
Publication date: 2014
Fully etched apodized grating coupler on the SOI platform with −0.58 dB coupling efficiency

We design and fabricate an ultrahigh coupling efficiency (CE) fully etched apodized grating coupler on the silicon-on-insulator (SOI) platform using subwavelength photonic crystals and bonded aluminum mirror. Fabrication error sensitivity and coupling angle dependence are experimentally investigated. A record ultrahigh CE of −0.58 dB with a 3 dB bandwidth of 71 nm and low back reflection are demonstrated.
Improved light extraction efficiency of InGaN/GaN light-emitting diodes using dielectric coated nanopillars
Nanopillars have been fabricated on InGaN/GaN light-emitting diodes using nanosphere lithography. With HCl treatment and SiN passivation a photoluminescence improvement by a factor of 7.8 was obtained compared to the untreated nanopillar structure.

Localized surface plasmon scattering efficiency improvement

Localized surface plasmon scattering efficiency improvement
Mode-selective wavelength conversion based on four-wave mixing in a multimode silicon waveguide

We propose and demonstrate all-optical mode-selective wavelength conversion in a silicon waveguide. The mode-selective wavelength conversion relies on strong four-wave mixing when pump and signal light are on the same spatial mode, while weak four-wave mixing is obtained between different modes due to phase mismatch. A two-mode division multiplexing circuit with tapered directional coupler based (de)multiplexers and a multimode waveguide is designed and fabricated for this application. Experimental results show clear eye Diagrams and moderate power penalties for the wavelength conversion of both modes.
Nucleation and growth of polycrystalline SiC
The nucleation and bulk growth of polycrystalline SiC in a 2 inch PVT setup using isostatic and pyrolytic graphite as substrates was studied. Textured nucleation occurs under near-thermal equilibrium conditions at the initial growth stage with hexagonal platelet shaped crystallites of 4H, 6H and 15R polytypes. It is found that pyrolytic graphite results in enhanced texturing of the nucleating gas species. Reducing the pressure leads to growth of the crystallites until a closed polycrystalline SiC layer containing voids with a rough surface is developed. Bulk growth was conducted at 35 mbar Ar pressure at 2250°C in diffusion limited mass transport regime generating a convex shaped growth form of the solid-gas interface leading to lateral expansion of virtually [001] oriented crystallites. Growth at 2350°C led to the stabilization of 6H polytypic grains. The micropipe density in the bulk strongly depends on the substrate used.

General information
State: Published
Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, University of Erlangen-Nuremberg, Linköping University, KTH - Royal Institute of Technology
Authors: Kaiser, M. (Ekstern), Schimmel, S. (Ekstern), Jokubavicius, V. (Ekstern), Linnarsson, M. K. (Ekstern), Ou, H. (Intern), Syväjärvi, M. (Ekstern), Wellmann, P. (Ekstern)
Number of pages: 7
Publication date: 2014
**On-chip grating coupler array on the SOI platform for fan-in/fan-out of multi-core fibers with low insertion loss and crosstalk**

We design and fabricate a compact multi-core fiber fan-in/fan-out using a fully-etched grating coupler array on the SOI platform. Lowest coupling loss of 6.8 dB with 3 dB bandwidth of 48 nm and crosstalk lower than ×32 dB are demonstrated.

**Optimization of light out-coupling in optoelectronic devices using nanostructured surface**

Light - emitting diodes (LEDs) are emerging as a future market leader for indoor and outdoor lighting because it has higher energy - efficiency, longer lifetime, more compact size and more flexible spectral design, compared to the conventional incandescent lamp and fluorescent light tubes. In order to fully explore the potential of this new light sources, huge amount of effort has been made to enhance the light extraction efficiency, which is usually very low due to the large refractive index difference between the semiconductor material s and the air, thus is very crucial in order to imp rove the overall efficiency of the LEDs. In this paper we have developed various methods for two important semiconductors: silicon carbide (SiC) and gallium nitride (GaN), and demonstrated enormous extraction efficiency enhancement. SiC is an important su bstrate for LED devices. It has refractive index of 2.6, and only a few percent of light could escape from it. We have developed periodic nanocone structures by using electron - beam lithography, periodic nanodome structures by using nanosphere lithography, random nanostructures by using self - assembled metal nanoparticles, and random nanostructures by directly using the self - masking effect of thin Al films, as shown in Fig.1. All these nanostructures have shown increased transmittance or reduced reflectance c ompared to the bare surface. Fluorescent SiC samples show
tremendous photoluminescence enhancement (up to 210%) after the surface nanostructuring. As active material for LEDs, GaN also has high refractive index of 2.4. So, it is also very important to extract more light out by roughening the surface. For GaN, the self-assembly method was applied. The same transmittance enhancement (15~20%) is demonstrated, similar to SiC. In addition to SiC and GaN, these developed methods could be applied to other semiconductors such as Si, etc. Furthermore, all optoelectronic devices having an optical interface such as solar cells, photo-detectors, could benefit from these developed methods for opto-electronic performance improvement.

**General information**

State: Published
Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems
Publication date: 2014
Event: Abstract from 3rd international symposium on dispersive systems for electronic applications, Erlangen, Germany.
Main Research Area: Technical/natural sciences
Electronic versions: abstract_Erlangen_Haiyan_Ou.pdf

**Bibliographical note**

Invited talk at 3rd international symposium on dispersive systems for electronic applications, Erlangen, Germany, September 11-12, 2014
Source: PublicationPreSubmission
Source-ID: 100009487
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2014

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**Parametric Phase-sensitive and Phase-insensitive All-optical Signal Processing on Multiple Nonlinear Platforms - Invited talk.**

Parametric processes in materials presenting a second- or third-order nonlinearity have been widely used to demonstrate a wide range of all-optical signal processing functionalities, including amplification, wavelength conversion, regeneration, sampling, switching, modulation format conversion, optical phase conjugation, etc. The recent evolution of optical communication systems towards advanced modulation formats making use of the phase dimension, as well as polarization- and, more recently, space-multiplexing, has created new requirements, as well as new opportunities, for parametric all-optical signal processing. In this presentation, we will review our recent results on the demonstration of all-optical parametric signal processing using different nonlinear platforms, including highly nonlinear optical fibers (HNLFs), silicon nanowires, and periodically-poled lithium niobate (PPLN) waveguides. In particular, we will show how phase-sensitive processes can be engineered to demonstrate phase-quadrature separation, which we have recently demonstrated in HNLFs [1] and PPLN waveguides [2]. Silicon nanowires are particularly attractive for signal processing thanks to their compact size, CMOS-compatible fabrication process, degrees of freedom in dispersion engineering, and high nonlinear coefficient. However, the detrimental effect of free-carrier absorption induced by two-photon absorption has so far prevented them from being used for the demonstration of phase-sensitive processing. Thanks to the introduction of p-i-n junctions across silicon waveguides, we have recently been able to demonstrate phase-sensitive extinction ratios as high as 20 dB, allowing the phase regeneration of phase-modulated signals under continuous wave pumping operation [3]. One of the well-known limitations of planar waveguide devices for all-optical signal processing is their inherent polarization-sensitivity. We will show how the introduction of polarization-diversity circuits relying on eicient and wideband polarization splitters and rotators [4] can overcome this limitation. Finally, we will also discuss the introduction of signal processing functionalities that are compatible with the novel dimension of space multiplexing. More specifically, we will show how mode-selective wavelength conversion based on four-wave mixing can be realized in a multimode silicon waveguide [5].

**General information**

State: Published
Organisations: Department of Photonics Engineering, High-Speed Optical Communication, Nanophotonic Devices, Diode Lasers and LED Systems, University of Rennes, Huazhong University of Science and Technology, Tokyo University of Science, Innovations for High Performance Microelectronics GmbH, Technische Universität Berlin, Technical University of Berlin
Publication date: 2014
Event: Abstract from 35th Progress In Electromagnetics Research Symposium, Guangzhou (Canton), China.
Main Research Area: Technical/natural sciences
Electronic versions: 20140420_PIERS_Peucheret.pdf

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Invited talk at Progress in electromagnetic research symposium (PIERS), Guangzhou, China, August 25-28, 2014
Plasmon enhanced green GaN light-emitting diodes - Invited paper.
High-efficiency gallium nitride (GaN) based blue light-emitting diode (LED) paves the way for solid state lighting to take the place of the conventional incandescent bulbs and fluorescent light tubes. Compared to the traditional light sources, solid state lighting is more efficient, more flexible in spectral design, more compact etc. The III-nitride (GaN, InN etc.) semiconductors are attracting a lot of research effort because the combination of both could emit light with wavelength range from UV to infrared. Basically one material platform could provide all the solutions to light sources. However huge amount of material development is needed before high efficiency devices are achieved. Among them, one effort area is the so called ‘green gap’, i.e. low efficiency for green color LEDs due to the large piezoelectric field in the quantum wells (QWs) when the In composition is high. From the material growth point of view, the efficiency of green LED is being improved by growing the GaInN material on non-polar or semi-polar surface of sapphire substrate. In parallel with the material growth effort, surface plasmons are implemented by taking use of the interaction between metals and active areas to increase the efficiency. In this paper, our work on using silver (Ag) nanoparticles (NPs) to enhance the efficiency of the green LEDs is reviewed. Both random and periodic Ag nanoparticles are studied. The random Ag nanoparticles are formed by thermal annealing of thin films. Periodic Ag nanoparticles are formed through nanosphere lithography. For both cases, emission enhancement is demonstrated. For periodic Ag nanoparticles, photoluminescence enhancement of 2.7 is observed with a nanodisk diameter of 330 nm. It is found that an optimal pitch exists for a given particle size. For the random Ag nanoparticles, low temperature photoluminescence (LTPL) was measured and internal quantum efficiency (IQE) enhancement by the surface plasmons was derived. Excitation power dependence of IQE enhancement is derived as well. It was found that the strong PL enhancement was partly due to LSP-QW coupling, and partly due to excitation source enhancement from the Ag NPs, and separating these effects we noted an IQE improvement due to LSP-QW coupling at 530 nm emission from 19.4% to 44.1% using large sized Ag NPs at 756 W/cm². It was also found that the IQE enhancement is strongly dependent on excitation power density, yielding highest enhancement factors allow free carrier densities. Where an IQE enhancement by a factor of 2.3 was observed at 756 W/cm², an enhancement factor of 8.1 was observed at 1 W/cm².

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Main Research Area: Technical/natural sciences
Electronic versions: PIIERS2014_Abstract_1_.pdf
Source: PublicationPreSubmission
Source-ID: 100009509
Publication: Research - peer-review › Paper – Annual report year: 2014

Polarization-insensitive wavelength conversion of 40 Gb/s NRZ-DPSK signals in a silicon polarization diversity circuit
Polarization insensitive wavelength conversion of a 40 Gb/s non-return-to-zero (NRZ) differential phase-shift keying (DPSK) data signal is demonstrated using four-wave mixing (FWM) in a silicon nanowire circuit. Polarization independence is achieved using a diversity circuit based on polarization rotators and splitters, which is fabricated by a simple process on the silicon-on-insulator (SOI) platform. Error-free performance is achieved with only 0.5 dB of power penalty compared to the wavelength conversion of a signal with well optimized input polarization. Additionally, data transmission over 161 km standard single-mode fiber (SSMF) is demonstrated at 40 Gb/s using optical phase conjugation (OPC) in the proposed circuit.

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Organisations: Department of Photonics Engineering, High-Speed Optical Communication, Nanophotonic Devices, Diode Lasers and LED Systems
Pages: 12467-12474
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Main Research Area: Technical/natural sciences

Publication information
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.

General information
State: Published
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
Authors: Fadil, A. (Intern), Iida, D. (Ekstern), Chen, Y. (Ekstern), Ma, J. (Ekstern), Ou, Y. (Intern), Petersen, P. M. (Intern), Ou, H. (Intern)
Number of pages: 7
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Main Research Area: Technical/natural sciences

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Web of Science (2017): Indexed yes
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Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 2.057 SNIP 1.684 CiteScore 5.3
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 2.103 SNIP 1.544 CiteScore 4.75
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.886 SNIP 1.51 CiteScore 4.06
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.458 SNIP 0.896 CiteScore 2.44
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
ISI indexed (2011): ISI indexed no
Original language: English
Inorganic LEDs, Nanoparticles, Nanophotonics and plasmonics
Electronic versions:
Published_manuscript_srep06392.pdf
DOIs:
10.1038/srep06392
The role of defects in fluorescent silicon carbide layers grown by sublimation epitaxy

Donor-acceptor co-doped SiC is a promising light converter for novel monolithic all-semiconductor white LEDs due to its broad-band donor-acceptor pair luminescence and potentially high internal quantum efficiency. Besides sufficiently high doping concentrations in an appropriate ratio yielding short radiative lifetimes, long nonradiative lifetimes are crucial for efficient light conversion. The impact of different types of defects is studied by characterizing fluorescent silicon carbide layers with regard to photoluminescence intensity, homogeneity and efficiency taking into account dislocation density and distribution. Different doping concentrations and variations in gas phase composition and pressure are investigated.

Ultra-low coupling loss fully-etched apodized grating coupler with bonded metal mirror

A fully etched apodized grating coupler with bonded metal mirror is designed and demonstrated on the silicon-on-insulator platform, showing an ultra-low coupling loss of only 1.25 dB with 3 dB bandwidth of 69 nm.
Ultra-wide band signal generation using a coupling-tunable silicon microring resonator

Ultra-wide band signal generation using a silicon microring resonator tuned to an NRZ-DPSK modulated optical carrier is proposed and demonstrated. The scheme is shown to enable the generation of UWB signals with switchable polarity and tunable bandwidth by simply tuning the coupling regions of the microring resonator. Monocycle pulses with both negative and positive polarities are successfully synthesized experimentally.

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices, High-Speed Optical Communication, Diode Lasers and LED Systems, Huazhong University of Science and Technology
Authors: Ding, Y. (Intern), Huang, B. (Intern), Peucheret, C. (Intern), Xu, J. (Intern), Ou, H. (Intern), Zhang, X. (Ekstern), Huang, D. (Ekstern)
Pages: 6078-6085
Publication date: 2014
Main Research Area: Technical/natural sciences

Publication information
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Volume: 22
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Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.48 SJR 1.487 SNIP 1.589
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.976 SNIP 1.755 CiteScore 3.78
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.349 SNIP 2.166 CiteScore 4.18
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.358 SNIP 2.226 CiteScore 4.38
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.587 SNIP 2.145 CiteScore 3.85
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 2.579 SNIP 2.606 CiteScore 4.04
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.943 SNIP 2.466
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 3.092 SNIP 2.669
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Wavelength conversion of a 128 Gbit/s DP-QPSK signal is demonstrated using FWM in a polarization diversity circuit with silicon nanowires as nonlinear elements. Error-free performances are achieved with a negligible power penalty.

General information
State: Published
Organisations: Department of Photonics Engineering, High-Speed Optical Communication, Nanophotonic Devices, Diode Lasers and LED Systems, University of Sydney, Monash University, University of Rennes
Pages: 312-313
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Photonics and Electrooptics, dual-polarization signals, four-wave mixing, Nonlinear optics, Optical polarization, Optical pumping, Optical signal processing, Optical wavelength conversion, Phase shift keying, Silicon, Wavelength conversion device
DOIs: 10.1109/IPCon.2014.6995369
Source: FindIt
Source-ID: 273408490
All-optical 10 Gb/s AND logic gate in a silicon microring resonator

An all-optical AND logic gate in a single silicon microring resonator is experimentally demonstrated at 10 Gb/s with 50% RZ-OOK signals. By setting the wavelengths of two intensity-modulated input pumps on the resonances of the microring resonator, field-enhanced four-wave mixing with a total input power of only 8.5 dBm takes place in the ring, resulting in the generation of an idler whose intensity follows the logic operation between the pumps. Clear and open eye diagrams with a bit-error ratio below 10–9 are achieved.

General information
State: Published
Organisations: Nanophotonic Devices, High-Speed Optical Communication, Department of Photonics Engineering, Diode Lasers and LED Systems, Huazhong University of Science and Technology
Authors: Xiong, M. (Intern), Lei, L. (Intern), Ding, Y. (Intern), Huang, B. (Intern), Ou, H. (Intern), Peucheret, C. (Intern), Zhang, X. (Ekstern)
Pages: 25772-25779
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Main Research Area: Technical/natural sciences

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Volume: 21
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  BFI (2017): BFI-level 2
  Web of Science (2017): Indexed yes
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  Web of Science (2016): Indexed yes
  BFI (2015): BFI-level 2
  Scopus rating (2015): SJR 1.976 SNIP 1.755 CiteScore 3.78
  Web of Science (2015): Indexed yes
  BFI (2014): BFI-level 2
  Scopus rating (2014): SJR 2.349 SNIP 2.166 CiteScore 4.18
  Web of Science (2014): Indexed yes
  BFI (2013): BFI-level 2
  Scopus rating (2013): SJR 2.358 SNIP 2.226 CiteScore 4.38
  ISI indexed (2013): ISI indexed yes
  Web of Science (2013): Indexed yes
  BFI (2012): BFI-level 2
  Scopus rating (2012): SJR 2.587 SNIP 2.145 CiteScore 3.85
  ISI indexed (2012): ISI indexed yes
  Web of Science (2012): Indexed yes
  BFI (2011): BFI-level 2
  Scopus rating (2011): SJR 2.579 SNIP 2.606 CiteScore 4.04
  ISI indexed (2011): ISI indexed yes
  Web of Science (2011): Indexed yes
  BFI (2010): BFI-level 2
  Scopus rating (2010): SJR 2.943 SNIP 2.466
  Web of Science (2010): Indexed yes
  BFI (2009): BFI-level 2
  Scopus rating (2009): SJR 3.092 SNIP 2.669
  Web of Science (2009): Indexed yes
  BFI (2008): BFI-level 2
  Scopus rating (2008): SJR 3.195 SNIP 2.393
  Web of Science (2008): Indexed yes
A scheme to expand the delay-bandwidth product in the resonator-based delay lines by optical OFDM technique

We propose a novel scheme to expand the inherent limit in the product of the optical delay and the transmission bandwidth in resonator-based delay lines, with the optical orthogonal frequency division multiplexing (OFDM) technique. The optical group delay properties of a single ring resonator were theoretically studied, and double-carrier OFDM signals were transmitted through such a device in the experiment, where the subcarrier-frequencies matched those of the resonant modes in the device. The results show that, although the delay-bandwidth product (DBP) is limited in the order of 50 ps×10 Gb/s for signals on each of the sub-carriers, the total DBP of the system is doubled to 2×50 ps×10 Gb/s due to the double-carrier transmission.
Broadband antireflection nanodome structures on SiC substrate

Nanodome structures are demonstrated on the SiC substrate by using nanosphere lithography and dry etching. Significant surface antireflection has been observed over a broad spectral range from 400 nm to 1600 nm.
Broadband antireflection silicon carbide surface by self-assembled nanopatterned reactive-ion etching

An approach of fabricating pseudoperiodic antireflective subwavelength structures on silicon carbide by using self-assembled Au nanopatterns as etching mask is demonstrated. The nanopatterning process is more time-efficiency than the e-beam lithography or nanoimprint lithography process. The influences of the reactive-ion etching conditions and deposited Au film thickness to the subwavelength structure profile and its corresponding surface reflectance have been systematically investigated. Under the optimal experimental conditions, the average reflectance of the silicon carbide in the range of 390x0<sub>784</sub> nm is dramatically suppressed from 21.0x0<sub>0.25</sub>; to 1.9x0<sub>0.25</sub>; after introducing the pseudoperiodic nanostructures. A luminescence enhancement of 226x0<sub>0.25</sub>; was achieved at an emission angle of 20x0<sub>0.0</sub>; on the fluorescent silicon carbide. Meanwhile, the angle-resolved photoluminescence study presents a considerable omnidirectional luminescence enhancement.
Broadband antireflective silicon carbide surface produced by cost-effective method

A cost-effective method for fabricating antireflective subwavelength structures on silicon carbide is demonstrated. The nanopatterning is performed in a 2-step process: aluminum deposition and reactive ion etching. The effect, of the deposited aluminum film thickness and the reactive ion etching conditions, on the average surface reflectance and nanostructure landscape have been investigated systematically. The average reflectance of silicon carbide surface is significantly suppressed from 25.4% to 0.05%, under the optimal experimental conditions, in the wavelength range of 390-784 nm. The presence of stochastic nanostructures also changes the wetting properties of silicon carbide surface from hydrophilic (47°) to hydrophobic (108°).
Characterization of GaInN/GaN quantum wells through surface plasmon coupling.

General information
State: Published
Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Programmable Phase Optics, Meijo University
Publication date: 2013
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Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2014

Combining DPSK and duobinary for the downstream in 40-Gb/s long-reach WDM-PONs
We propose and demonstrate combining differential phase-shift keying (DPSK) and duobinary transmission for the downstream in 40-Gb/s long-reach wavelength division multiplexed-passive optical networks (WDM-PONs) in order to provide robust transmission performance in the backhaul section and simple detection at the ONUs. DPSK is deployed in the trunk span as it provides stronger robustness to fiber nonlinearity. Duobinary is used in the access span where its higher chromatic dispersion tolerance relieves the need for dispersion compensation. All-optical multichannel modulation format conversion from DPSK to duobinary is realized in the local exchange in a single delay interferometer to reduce system cost. Single and multi-channel 80-km long-reach DPSK transmission and up to 5-km duobinary access transmission are experimentally demonstrated at 40Gb/s. The proposed approach shows great potential for future high data rate optical access networks.

General information
State: Published
Organisations: Nanophotonic Devices, High-Speed Optical Communication, Department of Photonics Engineering, Diode Lasers and LED Systems, Fudan University, Huazhong University of Science and Technology
Authors: Huang, B. (Intern), An, Y. (Intern), Chi, N. (Ekstern), Xiong, M. (Intern), Ou, H. (Intern), Liu, W. (Forskerdatabase), Peucheret, C. (Intern)
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Main Research Area: Technical/natural sciences

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Journal: Optical Fiber Technology
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Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.89 SJR 0.649 SNIP 1.129
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.841 SNIP 1.21 CiteScore 1.86
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.814 SNIP 1.352 CiteScore 1.88
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.703 SNIP 1.265 CiteScore 1.84
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Doping and stability of 3C-SiC: from thinfilm to bulk growth

Cubic silicon carbide (3C-SiC) could pave the way for development of advanced electronic and optoelectronic devices. It could be an excellent substrate for growth of nitride and epitaxial graphene layers. Boron doped 3C-SiC films could reach up to 60% efficiency and pave the way for a new solar cell technology. Nitrogen and boron doped 3C-SiC layers can depict a new infrared LED.

Hexagonal SiC is an excellent substrate for heteroepitaxial growth of 3C-SiC due to excellent compatibility in lattice constant and thermal expansion coefficient. However, the growth of 3C-SiC on such substrates is still being followed by a number of obstacles like polytype stabilization and high density of double positioning boundaries in the grown material. The polytype stability during epitaxial growth of doped 3C-SiC has not been explored. Consequently, the polytype stability during bulk growth of doped 3C-SiC is not known.

In this study we explore the growth of low and medium doped bulk-like 3C-SiC layers on off-oriented 6H-SiC substrates using a sublimation epitaxy technique. We compare SIMS, XRD and PL data obtained from 3C-SiC material grown using polycrystalline SiC sources prepared by CVD with a low (~10^{16}cm^{-3}) boron concentration and by PVT with a medium (~10^{18}cm^{-3}) nitrogen and boron concentrations. The effects of impurities on polytype stability and crystal quality of low and medium doped bulk-like 3C-SiC layers with thickness up to 0.5 mm are analysed. Moreover, the remaining challenges in growth of 3C-SiC for optoelectronic applications are discussed.
**Enhanced internal quantum efficiency of green emission GaInN/GaN multiple quantum wells by surface plasmon coupling**

**General information**
State: Published
Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Nanophotonic Devices, Meijo University
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Main Research Area: Technical/natural sciences
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Abstract JSAP_MRS2013_Iida.pdf
Source: dtu
Source-ID: u::9336
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2013

**Experimental Demonstration of Phase Sensitive Parametric Processes in a Nano-Engineered Silicon Waveguide**

We demonstrate experimentally phase-sensitive processes in nano-engineered silicon waveguides for the first time. Furthermore, we highlight paths towards the optimization of the phase-sensitive extinction ratio under the impact of two-photon and free-carrier absorption.

**General information**
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Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Nanophotonic Devices, High-Speed Optical Communication, Fiber Optics, Devices and Non-linear Effects
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Publisher: IEEE
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http://www.opticsinfobase.org/abstract.cfm?URI=CLEO_SI-2013-CM4D.7. Systematic or multiple reproduction or distribution to multiple locations via electronic or other means is prohibited and is subject to penalties under law.
Fabrication of antireflective SiC surface using plasma etching with self-assembled nanopattern

General information
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Organisations: Department of Photonics Engineering, Department of Micro- and Nanotechnology, Nanoprobes, Diode Lasers and LED Systems
Authors: Ou, Y. (Intern), Agyraki, A. (Intern), Ou, H. (Intern)
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Main Research Area: Technical/natural sciences
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Relations
Activities:
Fabrication of antireflective SiC surface using plasma etching with self-assembled nanopattern
39th International Conference on Micro and Nano Engineering
Source: dtu
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Publication: Research - peer-review › Poster – Annual report year: 2013

Fabrication of broadband antireflective sub-wavelength structures on fluorescent SiC
Surface nanocones on 6H-SiC have been developed and demonstrated as an effective method of enhancing the light extraction efficiency from fluorescent SiC layers. The surface reflectance, measured from the opposite direction of light emission, over a broad bandwidth range is significantly suppressed from 20.5% to 1.0% after introducing the sub-wavelength structures. An omnidirectional light harvesting enhancement (>91%), is also achieved which promotes fluorescent SiC as a good candidate of wavelength converter for white light-emitting diodes.

General information
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DOIs: 10.4028/www.scientific.net/MSF.740-742.1024
Publication: Research - peer-review › Article in proceedings – Annual report year: 2013
Lateral boron distribution in polycrystalline SiC source materials
Polycrystalline SiC containing boron and nitrogen are used in growth of fluorescent SiC for white LEDs. Two types of doped polycrystalline SiC have been studied in detail with secondary ion mass spectrometry: sintered SiC and poly-SiC prepared by sublimation in a physical vapor transport setup. The materials are co-doped materials with nitrogen and boron to a concentration of 1x10^18 cm^-3 and 1x10^19 cm^-3, respectively. Depth profiles as well as ion images have been recorded. According to ocular inspection, the analyzed poly-SiC consists mainly of 4H-SiC and 6H-SiC grains. In these grains, the boron concentration is higher and the nitrogen concentration is lower in the 6H-SiC compared to the 4H-SiC polytype. No inter-diffusion between grains is observed.

General information
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Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, KTH - Royal Institute of Technology, University of Erlangen-Nuremberg, Linköping University
Pages: 397-400
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Light extraction efficiency enhancement for fluorescent SiC based white light-emitting diodes
Fluorescent SiC based white light-emitting diodes(LEDs) light source, as an innovative energy-efficient light source, would even have longer lifetime, better light quality and eliminated blue-tone effect, compared to the current phosphor based white LED light source. In this paper, the yellow fluorescent Boron-Nitrogen co-doped 6H SiC is optimized in terms of source material, growth condition, dopant concentration, and carrier lifetime by using photoluminescence, pump-probe spectroscopy etc. The internal quantum efficiency is measured and the methods to increase the efficiency have been explored. At a device level, the focus is on improving the light extraction efficiency due to the rather high refractive index of SiC by nanostructuring the surface of SiC. Both periodic nanostructures made by e-beam lithography and nanosphere lithography and random nanostructures made by self-assembled Au nanosphere mask and a thin layer of Al film have been investigated and all of them showed much enhanced extraction efficiency. All these good results pave the way to a very promising fluorescent SiC based white LED light source.

General information
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Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Meijo University, Vilnius University , University of Erlangen-Nuremberg, KTH - Royal Institute of Technology, Linköping University
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Main Research Area: Technical/natural sciences
Electronic versions: prod11383296604801.abstract_ASEPE.pdf

Bibliographical note
Invited contribution.
Source: dtu
Source-ID: u::9282
Luminescence enhancement of fluorescent SiC via surface nanostructuring produced by 2-step cost effective method

General information
State: Published
Organisations: Department of Photonics Engineering, Department of Micro- and Nanotechnology, Nanoprobes, Diode Lasers and LED Systems, Linköping University
Authors: Argyraki, A. (Intern), Ou, Y. (Intern), Jokubavicius, V. (Ekstern), Syväjärvi, M. (Ekstern), Ou, H. (Intern)
Publication date: 2013
Main Research Area: Technical/natural sciences
Electronic versions: Luminescence enhancement of fluorescent SiC via surface nanostructuring produced by

Mode-Selective Wavelength Conversion Based on Four-Wave Mixing in a Multimode Silicon Waveguide
We report all-optical mode-selective wavelength conversion based on four-wave mixing in a multimode Si waveguide. A two-mode division multiplexing circuit using tapered directional coupler based (de)multiplexers is used for the application. Experimental results show clear eye-diagrams and moderate power penalties for the conversion of both modes.

General information
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Organisations: Department of Photonics Engineering, Nanophotonic Devices, High-Speed Optical Communication, Diode Lasers and LED Systems
Authors: Ding, Y. (Intern), Xu, J. (Intern), Ou, H. (Intern), Peucheret, C. (Intern)
Number of pages: 3
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Publication date: 2013

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Source: dtu
Source-ID: n:oai:DTIC-ART:iel/423544871::33593
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2013

Nanostructured Antireflection Layer, and Application of Same to LEDs
An optical device having a surface in a silicon carbide or gallium nitride material is provided, the optical device having a non-periodic nano structure formed in the surface, the nano structure comprising a plurality of cone shaped structures wherein the cones are distributed non-periodically on the surface. The plurality of cone shaped structures have a random height distribution and at least a part of the cone shaped structures have a height of at least 100 nm. The nonperiodicity ensures a uniform spatial light distribution after light exits out of the chip. A method of manufacturing a non-periodic nano structured surface on an optical device is furthermore provided, the method comprising the steps of providing a silicon carbide or gallium nitride device, forming a thin film of a masking material on at least a part of the substrate, treating the thin film to form nano islands of the thin film material, etching the substrate in a mostly anisotropic etch and concurrently etching at least a part of the thin film masking material to form a non-periodical nano structure, the nano structure comprising a plurality of cone shaped surface structures. The optical device may comprise a white LED or a wavelength converter for a white light source.
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Authors: Ou, H. (Intern)
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Publication information
IPC: G02B1/11; H01L33/30; H01L33/34; H01L33/50
Patent number: WO2013171284A1
Date: 12/11/2013
Original language: English

Bibliographical note
Main Research Area: Technical/natural sciences
Publication: Research › Patent – Annual report year: 2014

On-chip two-mode division multiplexing using tapered directional coupler-based mode multiplexer and demultiplexer
Abstract: We demonstrate a novel on-chip two-mode division multiplexing circuit using a tapered directional coupler-based TE0&TE1 mode multiplexer and demultiplexer on the silicon-on-insulator platform. A low insertion loss (0.3 dB), low mode crosstalk (< −16 dB), wide bandwidth (~100 nm), and large fabrication tolerance (20 nm) are measured. An on-chip mode multiplexing experiment is carried out on the fabricated circuit with non return-to-zero (NRZ) on-off keying (OOK) signals at 40 Gbit/s. The experimental results show clear eye diagrams and moderate power penalty for both TE0 and TE1 modes.

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Authors: Ding, Y. (Intern), Xu, J. (Intern), Da Ros, F. (Intern), Huang, B. (Intern), Ou, H. (Intern), Peucheret, C. (Intern)
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Main Research Area: Technical/natural sciences

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Scopus rating (2013): SJR 2.358 SNIP 2.226 CiteScore 4.38
ISI indexed (2013): ISI indexed yes
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Scopus rating (2012): SJR 2.587 SNIP 2.145 CiteScore 3.85
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
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Photoluminescence topography of fluorescent SiC and its corresponding source crystals

The preparation and application of co-doped polycrystalline SiC as source in sublimation growth of fluorescent layers is a complex topic. Photoluminescence topographies of luminescent 6H-SiC layers and their corresponding source crystals have been studied in order to investigate the dependence of the epitaxial growth on the source material. It is shown that the homogeneity concerning the dopant incorporation and the layer luminescence intensity does not depend on the characteristics of the PVT grown source material. Therefore co-doped polycrystalline SiC is a promising source material in fast sublimation growth of luminescent 6H-SiC.
Polarization diversity DPSK demodulator on the silicon-on-insulator platform with simple fabrication

We demonstrate a novel polarization diversity differential phase-shift keying (DPSK) demodulator on the SOI platform, which is fabricated in a single lithography and etching step. The polarization diversity DPSK demodulator is based on a novel polarization splitter and rotator, which consists of a tapered waveguide followed by a 2 × 2 multimode interferometer. A lowest insertion loss of 0.5 dB with low polarization dependent loss of 1.6 dB and low polarization dependent extinction ratio smaller than 3 dB are measured for the polarization diversity circuit. Clear eye-diagrams and a finite power penalty of only 3 dB when the input state of polarization is scrambled are obtained for 40 Gbit/s non return-to-zero DPSK (NRZ-DPSK) demodulation.
Polarization Diversity DPSK Demodulator on the Silicon-on-Insulator Platform with Simple Fabrication

We demonstrate a novel polarization diversity DPSK demodulator on the SOI platform with low polarization dependent loss (1.6 dB) and low polarization dependent extinction ratio (<3 dB). System experiments verify the low polarization dependency.

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices, High-Speed Optical Communication, Diode Lasers and LED Systems
Authors: Ding, Y. (Intern), Huang, B. (Intern), Ou, H. (Intern), Da Ros, F. (Intern), Peucheret, C. (Intern)
Pages: OTh4I.4
Publication date: 2013
Polycrystalline SiC as source material for the growth of fluorescent SiC layers

Polycrystalline doped SiC act as source for fluorescent SiC. We have studied the growth of individual grains with different polytypes in the source material. We show an evolution and orientation of grains of different polytypes in polycrystalline SiC ingots grown by the Physical Vapor Transport method. The grain influence on the growth rate of fluorescent SiC layers grown by a sublimation epitaxial process is discussed in respect of surface kinetics.

General information

State: Published
Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, University of Erlangen-Nuremberg, Linköping University, KTH - Royal Institute of Technology
Pages: 39-42
Publication date: 2013

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.

General information

State: Published
Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Structured Electromagnetic Materials, Meijo University
Number of pages: 3
Publication date: 2013
Robust 9-QAM digital recovery for spectrum shaped coherent QPSK signal

We propose 9-ary quadrature amplitude modulation (9-QAM) data recovery for polarization multiplexing-quadrature phase shift keying (PM-QPSK) signal in presence of strong filtering to approach Nyquist bandwidth. The decision-directed least radius distance (DD-LRD) algorithm for blind equalization is used for 9-QAM recovery and intersymbol interference (ISI) compression. It shows the robustness under strong filtering to recover 9-QAM signal rather than QPSK. We demonstrate 112 Gb/s spectrum shaped PM-QPSK signal by wavelength selective switch (WSS) in a 25-GHz channel spacing Nyquist wavelength division multiplexing (NWDM). The final equalized signal is detected by maximum likelihood sequence decision (MLSD) for data bit-error-ratio (BER) measurement. Optical signal-to-noise ratio (OSNR) tolerance is improved by 0.5 dB at a BER of 1x10-3 compared to constant modulus algorithm (CMA) plus post-filter algorithm.

General information
State: Published
Organisations: Nanophotonic Devices, High-Speed Optical Communication, Department of Photonics Engineering, Diode Lasers and LED Systems, Fudan University, ZTE Corporation, Huazhong University of Science and Technology
Authors: Huang, B. (Intern), Zhang, J. (Ekstern), Yu, J. (Ekstern), Dong, Z. (Ekstern), Li, X. (Ekstern), Ou, H. (Intern), Chi, N. (Ekstern), Liu, W. (Forskerdatabase)
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ISI indexed (2013): ISI indexed yes
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Scopus rating (2012): SJR 2.587 SNIP 2.145 CiteScore 3.85
ISI indexed (2012): ISI indexed yes
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Scopus rating (2011): SJR 2.579 SNIP 2.606 CiteScore 4.04
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Scopus rating (2010): SJR 2.943 SNIP 2.466
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 3.092 SNIP 2.669
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 3.195 SNIP 2.393
We propose and demonstrate a novel silicon photonic integrated circuit enabling multiplexing of orthogonal modes in a few-mode fiber (FMF). By selectively launching light to four vertical grating couplers, all six orthogonal spatial and polarization modes supported by the FMF are successfully excited independently.

**Silicon Photonic Integrated Circuit Mode Multiplexer**

We propose and demonstrate a novel silicon photonic integrated circuit enabling multiplexing of orthogonal modes in a few-mode fiber (FMF). By selectively launching light to four vertical grating couplers, all six orthogonal spatial and polarization modes supported by the FMF are successfully excited independently.
Simultaneous Polarization Demultiplexing and Demodulation of PolMux-DPSK Signals in a Silicon Chip

Simultaneous polarization demultiplexing and demodulation of PolMux-DPSK signals is demonstrated using a polarization splitter and rotator together with a single microring resonator on a silicon chip. System experimental results validate the concept.

Solar Cells Having a Nanostructured Antireflection Layer

An solar cell having a surface in a first material is provided, the optical device having a non-periodic nanostructure formed in the surface, the nanostructure comprising a plurality of cone-shaped structures wherein the cones are distributed non-periodically on the surface and have a random height distribution, at least a part of the cone-shaped structures having a height of at least 100 nm. The first material may be SiC or GaN. A method of manufacturing a non-periodic nanostructured surface on a solar cell, is furthermore provided, the method comprising the steps of providing a surface comprising SiC or GaN, forming a thin film of a masking material on at least a part of the substrate, treating the thin film to form nano islands of the thin film material, etching the SiC or GaN in a substantially anisotropic etch and concurrently etching at least a part of the thin film masking material to form a non-periodical nano structure, the nano structure comprising a plurality of cone-shaped surface structures, whereby the structures have a random height distribution, at least a part of the structures having a height of at least 100 nm.

Step-flow growth of fluorescent 4H-SiC layers on 4 degree off-axis substrates

Homoepitaxial layers of fluorescent 4H-SiC were grown on 4 degree off-axis substrates by sublimation epitaxy. Luminescence in the green spectral range was obtained by co-doping with nitrogen and boron utilizing donor-acceptor pair luminescence. This concept opens possibilities to explore green light emitting diodes using a new materials platform.
Systematic comparison of FWM conversion efficiency in silicon waveguides and MRRs

Wavelength conversion based on four-wave mixing is theoretically compared in silicon micro-ring resonators and nanowires under the effect of nonlinear loss. The impact of the bus waveguide length and MRR position are also quantified.

The role of defects in fluorescent silicon carbide layers grown by sublimation epitaxy

Donor-acceptor co-doped silicon carbide layers are promising light converters for novel monolithic all-semiconductor LEDs due to their broad-band donor-acceptor pair luminescence and potentially high internal quantum efficiency. Besides appropriate doping concentrations yielding low radiative lifetimes, high nonradiative lifetimes are crucial for efficient light conversion.

Despite the excellent crystalline quality that can generally be obtained by sublimation epitaxy according to XRD measurements, the role of defects in f-SiC is not yet well understood.

Recent results from room temperature photoluminescence, charge carrier lifetime measurements by microwave detected photoconductivity and internal quantum efficiency measurements suggest that the internal quantum efficiency of f-SiC layers is significantly affected by the incorporation of defects during epitaxy. Defect formation seems to be related to nitrogen incorporation from the growth ambient while nitrogen doping from the source yielded better results regarding quantum efficiency. To investigate the presence of different types of defects in f-SiC layers and their impact on the fluorescent properties of f-SiC, this study will focus on defect characterization of f-SiC layers grown under different process conditions, especially different growth ambient and using differently doped source material. The results may help to identify critical process parameters and reduce the concentration of relevant defects.
Ultra-High-Efficiency Apodized Grating Coupler Using a Fully Etched Photonic Crystal

We present an efficient method to design apodized grating couplers with Gaussian output profiles for efficient coupling between standard single mode fibers and silicon chips. An apodized grating coupler using fully etched photonic crystal holes on the silicon-on-insulator platform is designed, and fabricated in a single step of lithography and etching. An ultralow coupling loss of $-1.74 \text{ dB}$ (67% coupling efficiency) with a 3 dB bandwidth of 60 nm is experimentally measured.
Wideband polarization splitter and rotator with large fabrication tolerance and simple fabrication process

We propose and demonstrate a polarization splitter and rotator (PSR) built on a silicon-on-insulator platform. The PSR is constructed with a tapered waveguide followed by a 2×2 multimode interferometer and can be simply fabricated in a single lithography and etching step. A low insertion loss (<2.5 dB with minimum insertion loss of 0.6 dB) and a low polarization crosstalk (<−12 dB) over a wide operation bandwidth (∼100 nm) with a large fabrication tolerance (>50 nm) are experimentally demonstrated.
Wide-band Polarization Splitter and Rotator with Large Fabrication Tolerance and Simple Fabrication Process

We demonstrate a polarization splitter and rotator built on the silicon-on-insulator platform. The device shows low insertion loss (0.6 dB), low polarization crosstalk (<-12 dB), wide bandwidth (~100 nm), and large fabrication tolerance (60 nm).

General information
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Organisations: Department of Photonics Engineering, Nanophotonic Devices, High-Speed Optical Communication, Diode Lasers and LED Systems
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Conference: 2013 Optical Fiber Communication Conference and Exposition and the National Fiber Optic Engineers Conference, Anaheim, CA, United States, 17/03/2013 - 17/03/2013
41.6 Gb/s RZ-DPSK to NRZ-DPSK Format Conversion in a Microring Resonator

RZ-DPSK to NRZ-DPSK format conversion in a silicon microring resonator is demonstrated experimentally for the first time at 41.6 Gb/s. The converted signal eye diagrams and bit-error-rate measurements show the good performance of the scheme.

Broadband and omnidirectional light harvesting enhancement of fluorescent SiC

In the present work, antireflective sub-wavelength structures have been fabricated on fluorescent 6H-SiC to enhance the white light extraction efficiency by using the reactive-ion etching method. Broadband and omnidirectional antireflection characteristics show that 6H-SiC with antireflective sub-wavelength structures suppress the average surface reflection significantly from 20.5% to 1.01% over a wide spectral range of 390-784 nm. The luminescence intensity of the fluorescent 6H-SiC could be enhanced in the whole emission angle range. It maintains an enhancement larger than 91% up to the incident angle of 70 degrees, while the largest enhancement of 115.4% could be obtained at 16 degrees. The antireflective sub-wavelength structures on fluorescent 6H-SiC could also preserve the luminescence spectral profile at a large emission angle by eliminating the Fabry-Perot microcavity interference effect.
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Scopus rating (2016): CiteScore 3.48 SJR 1.487 SNIP 1.589
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Scopus rating (2015): SJR 1.976 SNIP 1.755 CiteScore 3.78
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BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.349 SNIP 2.166 CiteScore 4.18
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.358 SNIP 2.226 CiteScore 4.38
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.587 SNIP 2.145 CiteScore 3.85
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 2.579 SNIP 2.606 CiteScore 4.04
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.943 SNIP 2.466
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 3.092 SNIP 2.669
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 3.195 SNIP 2.393
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 3.27 SNIP 2.032
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Scopus rating (2006): SJR 3.233 SNIP 2.326
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 3.334 SNIP 2.379
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 2.833 SNIP 2.499
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 2.688 SNIP 2.193
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 1.547 SNIP 1.673
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 1.442 SNIP 1.39
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 1.246 SNIP 0.714
Web of Science (2000): Indexed yes
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Bibliographical note
Broadband light-extraction enhanced by arrays of whispering gallery resonators

We demonstrate a light-extraction approach using a whispering gallery resonators array. The wavelength-scale resonant dielectric nanospheres support whispering gallery modes, which can be coupled with the confined waveguide modes inside the bulk material, thus dramatically improving light extraction. Broadband light-extraction enhancement across the entire visible spectral range is achieved by exciting three low-order and low-quality-factor resonances. As an example, the broadband extraction enhancement of about 50% is obtained for the emission of fluorescent SiC at all the tested angles. The experimental results are supported by numerical simulations. Our light-extraction strategy could enable the manufacturing of high-throughput, nondestructive, and affordable optical coating in a variety of optical devices.
Characterization of donor-acceptor-pair emission in fluorescent 6H-SiC

We investigated donor-acceptor-pair emission in N-B-doped 6H-SiC samples by using photoluminescence (PL) and angle-resolved PL. It is shown that n-type doping with concentrations larger than 10^18 cm\(^{-3}\) is favorable for observing luminescence, and increasing nitrogen results in stronger luminescence. A dopant concentration difference greater than 4x10^18 cm\(^{-3}\) is proposed to help achieve intense PL. Angular-dependent PL was observed that was attributed to the Fabry-Perot microcavity interference effect, and a strong luminescence intensity in a large emission angle range was also achieved. The results indicate that N-B-doped fluorescent SiC is a good wavelength converter in white LED applications.
Characterization of donor–acceptor-pair emission in fluorescent 6H-SiC

We investigated donor–acceptor-pair emission in N–B-doped 6H-SiC samples by using photoluminescence (PL) and angle-resolved PL. It is shown that n-type doping with concentrations larger than 1018 cm−3 is favorable for observing luminescence, and increasing nitrogen results in stronger luminescence. A dopant concentration difference greater than 4×1018 cm−3 is proposed to help achieve intense PL. Angular-dependent PL was observed that was attributed to the Fabry–Pérot microcavity interference effect, and a strong luminescence intensity in a large emission angle range was also achieved. The results indicate that N–B-doped fluorescent SiC is a good wavelength converter in white LED applications.

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Organisations: Department of Photonics Engineering, Nanophotonic Devices, Linköping University, KTH - Royal Institute of Technology
Authors: Ou, Y. (Intern), Jokubavicius, V. (Ekstern), Linnarsson, M. (Ekstern), Yakimova, R. (Ekstern), Syväjärvi, M. (Ekstern), Ou, H. (Intern)
Pages: 014003
Crystal growth and characterization of fluorescent SiC

Silicon carbide (SiC) is widely used as substrate for nitride based light emitting diodes (LEDs). For today’s white LEDs mainly a sandwich structure of a blue or ultra violet LED and a yellowish phosphorus is used. In the frame of European project we study a concept to implement the functionality of the phosphorus into the SiC substrate to make an all semiconductor white LED. In recent years, due to the improvement of the crystalline quality of SiC by the so called fast sublimation growth process (FSGP), high room temperature internal quantum efficiencies of the yellow donor acceptor pair luminescence of 6H-SiC co-doped with nitrogen and boron has been achieved [1][2]. The source is the rate determining step, and is expected to be determining the fluorescent properties by introducing dopants to the layer from the source. The optimization process of the polycrystalline, co-doped SiC:B,N source material and its impact on the FSGP epitaxial process, in particular the influence on the brightness of the fluorescent 6H-SiC is presented. In addition we have investigated how the grain orientation of the poly-SiC source material changes the growth rate during the fast epitaxial growth process. Using shadow masks we have isolated sublimation from selected SiC grains with varying crystallographic orientation and measured the average growth rate (Fig. 1). The growth rate increases with increasing off-angle from (0001) crystallographic orientation.
which is attributed to surface kinetics during sublimation.

**General information**
State: Published
Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, University of Erlangen-Nuremberg, Linköping University, KTH - Royal Institute of Technology
Number of pages: 1
Publication date: 2012
Event: Abstract from European Conference on Crystal Growth (ECCG4), Glasgow, United Kingdom.
Main Research Area: Technical/natural sciences

**Enhanced extraction efficiency of fluorescent SiC by surface nanostructuring**
Antireflective structures were fabricated on fluorescent 6H-SiC for white LEDs to enhance the extraction efficiency. Average surface reflectance decreased from 22.1% to 5.1% over a broad range, and luminescence intensity was enhanced by 41%.

**General information**
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Organisations: Department of Photonics Engineering, Nanophotonic Devices, Linköping University
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**Fabrication of broadband antireflective sub-wavelength structures on fluorescent SiC**

**General information**
State: Published
Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Linköping University, University of Erlangen-Nuremberg, KTH - Royal Institute of Technology
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Fabrication tolerant polarization splitter and rotator based on a tapered directional coupler

A polarization splitter and rotator (PSR) based on a tapered directional coupler with relaxed fabrication tolerance is proposed and demonstrated on the silicon-on-insulator platform. The device is simply constructed by parallel-coupling a narrow silicon waveguide with a linearly tapered wider waveguide. Compared to previously reported PSRs based on a normal directional coupler, which suffer from stringent requirements on the accuracy of the narrow waveguide width, the introduced tapered structure of the wide waveguide can be used to compensate the fabrication errors of the narrow waveguide. In addition, only a single step of exposure and etching is needed for the fabrication of the device. Similar high conversion efficiencies are experimentally demonstrated for a narrow waveguide width deviation of 14 nm with large tolerance to the coupler length.

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Organisations: Department of Photonics Engineering, Nanophotonic Devices, High-Speed Optical Communication, Diode Lasers and LED Systems, South China Normal University
Authors: Ding, Y. (Intern), Liu, L. (Ekstern), Peucheret, C. (Intern), Ou, H. (Intern)
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Fluorescent SiC as a new material for white LEDs

Current III–V-based white light-emitting diodes (LEDs) are available. However, their yellow phosphor converter is not efficient at high currents and includes rare-earth metals, which are becoming scarce. In this paper, we present the growth of a fluorescent silicon carbide material that is obtained by nitrogen and boron doping and that acts as a converter using a semiconductor. The luminescence is obtained at room temperature, and shows a broad luminescence band characteristic of donor-to-acceptor pair recombination. Photoluminescence intensities and carrier lifetimes reflect a sensitivity to nitrogen and boron concentrations. For an LED device, the growth needs to apply low-off-axis substrates. We show by ultra-high-resolution analytical transmission electron microscopy using aberration-corrected electrons that the growth mechanism can be stable and that there is a perfect epitaxial relation from the low-off-axis substrate and the doped layer even when there is step-bunching.
Fluorescent SiC as a New Platform for Visible and Infrared Emitting Applications as Well as Prospective Photovoltaics

Fluorescent SiC is a novel materials system which may be a new platform for visible and infrared emitting applications. Although SiC is an indirect bandgap semiconductor, the donor acceptor pair emissions involving deep acceptors could become efficient if the acceptor envelope function are sufficiently localized. Nitrogen and boron co-doped SiC exhibits a high efficient donor acceptor pair emission at room temperature. Such donor acceptor pair emission exhibits a broad emission band in the wavelength ranging from visible to infrared region depending on the SiC polytypes. In 6H-SiC the emission appears in the visible range from 500 to 700 nm with a peak at 580 nm, appearing as a warm white color, while 4H yields a peak in the green region from 450 to 650 nm with a peak at 520 nm. The 3C-SiC polytype has a lower bandgap than its hexagonal counterparts which results in an emission in the infrared region from 700 to 900 nm with a peak at 830 nm. Further on, the boron is a deep level and replacing the boron with the aluminum, being a shallow acceptor, would open up further emissions in the visible and infrared regions that would allow tuning of emission for selected purposes. The combination of the polytypes covers a broad range of emission in the visible and infrared region, and the fluorescent SiC can act as a base material for SiC based light emitting materials having benefits of the SiC properties such as chemical stability, high thermal conduction and matching with nitride growth for LED fabrication. In addition, the cubic silicon carbide offers a potential solar cell material. Boron doped cubic SiC fits as a suitable concept for impurity (intermediate bandgap) photovoltaics with an efficiency up to 48-60% depending on the theoretical model. The requirement is a high material quality to have efficient optoelectronic transitions. We have shown that 3C-SiC could be grown in a very high quality. Carrier lifetime is one of the key parameters governing the electronic and optoelectronic devices. Very recently we have synthesized high quality 3C-SiC by a PVT process on 6H-SiC and with a very high growth rate of 1 mm per hour. The result is a carrier lifetime of 8.2 μs, and surprisingly this is even higher than in 4H-SiC when comparing carrier lifetimes in asgrown materials. Such material paves the way to explore cubic SiC for photovoltaics.
Fluorescent SiC based all semiconductor white LED

The strong photoluminescence from f-SiC was achieved after the optimization of the B and N concentrations. Surface nanostructures were successfully applied to enhance the extraction efficiency. f-SiC is a promising wavelength convertor for white LEDs.

Fluorescent SiC for white light-emitting diodes

The strong photoluminescence from f-SiC was achieved after the optimization of the B and N concentrations. Surface nanostructures were successfully applied to enhance the extraction efficiency. f-SiC is a promising wavelength convertor for white LEDs.
Fluorescent SiC with pseudo-periodic moth-eye structures

White light-emitting diodes (LEDs) consisting of a nitride-based blue LED chip and phosphor are very promising candidates for the general lighting applications as energy-saving sources. Recently, donor-acceptor doped fluorescent SiC has been proven as a highly efficient wavelength converter material much superior to the phosphors in terms of high color rendering index value and long lifetime. The light extraction efficiency of the fluorescent SiC based all semiconductor LED light sources is usually low due to the large refractive index difference between the semiconductor and air. In order to enhance the extraction efficiency, we present a simple method to fabricate the pseudo-periodic moth-eye structures on the surface of the fluorescent SiC. A thin gold layer is deposited on the fluorescent SiC first. Then the thin gold layer is treated by rapid thermal processing. After annealing, the thin gold layer turns into discontinuous nano-islands. The average size of the islands is dependent on the annealing condition which could be well controlled. By using the reactive-ion etching, pseudo-periodic moth-eye structures would be obtained using the gold nano-islands as a mask layer. Reactive-ion etching conditions are carefully optimized to obtain the lowest surface reflection performance of the fabricated structures. Significant omnidirectional luminescence enhancement (226.0%) was achieved from the angle-resolved photoluminescence measurement, which proves the pseudo-periodic moth-eye structure as an effective and simple method to enhance the extraction efficiency of fluorescent SiC based white LEDs. © (2012) COPYRIGHT Society of Photo-Optical Instrumentation Engineers (SPIE). Downloading of the abstract is permitted for personal use only.
Fluorescent Silicon Carbide and its Applications in White Light-Emitting Diodes

This thesis focuses on the optical properties analysis of Donor-Acceptor-Pair (DAP) co-doped Fluorescent Silicon Carbide (f-SiC) as a wavelength conversion material in white Light-Emitting Diodes (LEDs). Different methods of fabricating surface Antireflective Structures (ARS) on f-SiC to enhance its light extraction efficiency are presented.

White LEDs are the most promising techniques to replace the conventional lighting sources. A typical white LED consists of a Gallium Nitride (GaN) blue or Ultraviolet (UV) LED stack and a wavelength conversion material. Silicon Carbide (SiC) has a wide optical bandgap and could be tailored to emit light at different wavelengths by introducing different dopants. Combined emitting spectra of two types of DAP co-doped f-SiC could cover the whole visible spectral range and make f-SiC a good candidate of wavelength conversion material. It has a better color rendering performance and a much longer material lifetime compared with the commonly used wavelength conversion material like Phosphors. In this thesis, f-SiC with different doping concentrations are analyzed and optimized in order to enhance the quantum efficiency.

On the other hand, semiconductor materials usually suffer from the low light extraction efficiency due to the large refractive index difference between air and semiconductor interface. To ease this limitation, ARS have been widely applied on the semiconductor surface in LED and solar cell applications. This thesis has theoretically investigated the impact of surface ARS on colorimetry and light extraction efficiency of f-SiC based white LED. Furthermore, various approaches of fabricating periodic and pseudoperiodic ARS are demonstrated. By introducing ARS, a significant surface reflection suppression and a considerable omnidirectional luminescence enhancement have been observed.
**Fluorescent silicon carbide materials for white LEDs and photovoltaics**

Energy efficient materials solutions will be key figures in progressive energy saving applications. We explore a materials growth concept of fluorescent wide bandgap semiconductors for white and infrared LEDs as well as solar cells. This is an emerging scientific field which has not previously been explored.

The applications include a white LED for general lighting in which the conversion is based on the semiconductor instead of using phosphors. The result is an LED technology which does not need rare earth metals and has a pure white light. In efficient fluorescent materials, the absorption may be very efficient. This leads to the concept of using wide bandgap fluorescent materials for solar cells. The efficiency is increased by introducing certain dopants, so that solar absorption is increased in a single material. This is an advantage to multijunction solar cells where there are electron losses at each junction.

We have applied novel methods to produce the fluorescent materials [1]. Thick doped silicon carbide layers may be grown to produce a voluminous medium from which the dopants act to produce a donor to acceptor pair recombination mechanism. In hexagonal silicon carbide the luminescence appears in the visible region which is used to produce a white LED with pure white light without need of phosphors [2]. The cubic silicon carbide polytype is challenging to master, and we have explored the growth of this crystal structure. It has a lower bandgap, and by a similar doping concept the luminescence appears in the infrared region in a broad range from 700 to 1100 nm. This potentially can be used to develop an infrared LED for de-icing in wind power and airplanes, or medical applications. Further on, a very efficient solar cell material can be investigated by studying the impurity effect in cubic silicon carbide. The impurity photovoltaic effect could lead to devices with efficiencies comparable to those of tandem systems, and could open a new road for very-high-efficiency solar cells. Such high performance can be reached only if the host material has a large energy gap, like cubic silicon carbide [3,4].

**Lateral boron distribution in polycrystalline SiC source for growth of fluorescent 6H-SiC**

**Linear signal processing using silicon micro-ring resonators**

We review our recent achievements on the use of silicon micro-ring resonators for linear optical signal processing applications, including modulation format conversion, phase-to-intensity modulation conversion and waveform shaping.

**General information**

State: Published
Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Linköping University, University of Erlangen-Nuremberg
Authors: Syväjärvi, M. (Ekstern), Ou, H. (Intern), Wellmann, P. (Ekstern)
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Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, KTH - Royal Institute of Technology, University of Erlangen-Nuremberg, Linköping University
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**General information**

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Organisations: Department of Photonics Engineering, High-Speed Optical Communication, Nanophotonic Devices, Diode Lasers and LED Systems, South China Normal University, Wuhan National Laboratory for Optoelectronics
Modulation Speed Enhancement of Directly Modulated Lasers Using a Micro-ring Resonator

A silicon micro-ring resonator is used to enhance the modulation speed of a 10-Gbit/s directly modulated laser to 40 Gbit/s, demonstrating a potentially integratable transmitter design for high-speed optical interconnects.
Omnidirectional luminescence enhancement of fluorescent SiC via pseudoperiodic antireflective subwavelength structures

In the present work, an approach of fabricating pseudoperiodic antireflective subwavelength structures (ARS) on fluorescent SiC by using self-assembled etch mask is demonstrated. By applying the pseudoperiodic (ARS), the average surface reflectance at 6° incidence over the spectral range of 390-785 nm is dramatically suppressed from 20.5% to 1.62%, and the hydrophobic surface with a large contact angle of 98° is also achieved. The angle-resolved photoluminescence study presents a considerable omnidirectional luminescence enhancement with an integral intensity enhancement of 66.3% and a fairly preserved spatial emission pattern. © 2012 Optical Society of America.
On-chip Mode Multiplexer Based on a Single Grating Coupler

A two-mode multiplexer based on a single grating coupler is proposed and demonstrated on a silicon chip. The LP01 and LP11 modes of a few-mode fiber are excited from TE0 and TE1 silicon waveguide modes.

Photoluminescence and Raman Spectroscopy Characterization of Boron- and Nitrogen-Doped 6H Silicon Carbide

Nitrogen-boron doped 6H-SiC epilayers grown on low off-axis 6H-SiC substrates have been characterized by photoluminescence and Raman spectroscopy. The photoluminescence results show that a doping larger than $10^{18}$ cm$^{-3}$ is favorable to observe the luminescence and addition of nitrogen is resulting in an increased luminescence. A dopant concentration difference larger than $4 \times 10^{18}$ cm$^{-3}$ is proposed to achieve intense photoluminescence. Raman spectroscopy further confirmed the doping type and concentrations for the samples. The results indicate that N-B doped SiC is being a good wavelength converter in white LEDs applications.
Photoluminescence topography of fluorescent SiC and its corresponding source crystals

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Polycrystalline SiC as source material for the growth of fluorescent SiC layers

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Simultaneous RZ-OOK to NRZ-OOK and RZ-DPSK to NRZ-DPSK format conversion in a silicon microring resonator

Simultaneous RZ-OOK to NRZ-OOK and RZ-DPSK to NRZDPSK modulation format conversion in a single silicon microring resonator with free spectral range equal to twice the signal bit rate is experimentally demonstrated for the first time at 41.6 Gb/s. By utilizing an optimized custom-made microring resonator with high coupling coefficient followed by an optical bandpass filter with appropriate bandwidth, good conversion performances for both modulation formats are achieved according to the converted signals eye diagrams and bit-error-rate measurements.

General information
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Organisations: Nanophotonic Devices, High-Speed Optical Communication, Department of Photonics Engineering, Diode Lasers and LED Systems, Huazhong University of Science and Technology
Authors: Xiong, M. (Intern), Ozolins, O. (Intern), Ding, Y. (Intern), Huang, B. (Intern), An, Y. (Intern), Ou, H. (Intern), Peucheret, C. (Intern), Zhang, X. (Ekstern)
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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.

General information

State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices, Diode Lasers and LED Systems
Authors: Ou, H. (Intern), Corell, D. D. (Intern), Ou, Y. (Intern), Poulsen, P. B. (Intern), Dam-Hansen, C. (Intern), Petersen, P. M. (Intern)
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Step-flow growth of fluorescent 4H-SiC layers on 4 degree off-axis substrates

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Three-dimensional fabrication and characterisation of core-shell nano-columns using electron beam patterning of Ge-doped SiO₂

A focused electron beam in a scanning transmission electron microscope (STEM) is used to create arrays of core-shell structures in a specimen of amorphous SiO₂ doped with Ge. The same electron microscope is then used to measure the changes that occurred in the specimen in three dimensions using electron tomography. The results show that transformations in insulators that have been subjected to intense irradiation using charged particles can be studied directly in three dimensions. The fabricated structures include core-shell nano-columns, sputtered regions, voids, and clusters. (C) 2012 American Institute of Physics. [http://dx.doi.org/10.1063/1.4731765]

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Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Instituto de Ciencia de Materiales de Sevilla, FEI Europe, University of Antwerp, Forschungs Zentrum Jülich GmbH
Authors: Gontard, L. C. (Ekstern), Jinschek, J. R. (Ekstern), Ou, H. (Intern), Verbeeck, J. (Ekstern), Dunin-Borkowski, R. E. (Ekstern)
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Scopus rating (2008): SJR 2.934 SNIP 1.83
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 3.039 SNIP 1.913
Web of Science (2007): Indexed yes
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Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 3.709 SNIP 2.382
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 3.904 SNIP 2.38
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 3.765 SNIP 2.27
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 3.917 SNIP 2.365
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 4.111 SNIP 2.212
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 4.277 SNIP 2.013
Transmission Property of Directly Modulated Signals Enhanced by a Micro-ring Resonator

A silicon micro-ring resonator is used to enhance the modulation speed of a 10-Gbit/s directly modulated laser to 40 Gbit/s. The generated signal is transmitted error free over 4.5 km SSMF. Dispersion tolerance is also studied.

General information
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Silicon Nano-Photonic Devices

This thesis deals with the design, fabrication and characterization of nano-photonic devices including ridge waveguide components, microring resonators, and photonic crystal components, and explore the potential for these devices in different applications ranging from optical communication to microwave systems and biosensing devices. An ultra-low loss inverse taper coupler for interfacings silicon ridge waveguides and optical bers is introduced and insertion losses of less than 1 dB are achieved for both transverse-electric (TE) and transversemagnetic (TM) polarizations. Integrated with the couplers, a silicon ridge waveguide is utilized in nonlinear all-optical signal processing for optical time division multiplexing (OTDM) systems. Record ultra-highspeed error-free optical demultiplexing and waveform sampling are realized and demonstrated for the rst time. Microwave phase shifters and notch lters based on tunable microring resonators are proposed and analyzed. Based on a single microring resonator, a maximum radio frequency (RF) phase shift of 336 degrees is obtained, but with large power variation. By utilizing a dual-microring resonator, a RF phase shifting range larger than 2pi is achieved with small power variation. A widely tunable microwave notch lter is also experimentally demonstrated at 40 GHz. Other application such as pulse repetition rate multiplication by using microring resonator is also presented. Photonic crystal components are studied. Two dierent types of photonic crystal structures are analyzed concerning index sensitivity, dispersion engineering, and slow-light coupling. Several photonic crystal devices such as index sensor, slow-light coupler, and all-optical tunable cavity are presented.

General information
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Organisations: Nanophotonic Devices, Department of Photonics Engineering, Nanophotonics Theory and Signal Processing
Authors: Pu, M. (Intern), Hvam, J. M. (Intern), Yvind, K. (Intern), Ou, H. (Intern)
Number of pages: 155
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.
A novel and simple bandwidth and wavelength-tunable optical bandpass filter based on silicon microring-MZI structure is proposed and demonstrated. In this filter design, the drop transmissions of two microring resonators are combined to provide the desired tunability. A detailed analysis and the design of the device are presented. The shape factor and extinction ratio of the filter are optimized by thermally controlling the phase difference between the two arms of the MZI. Simultaneous bandwidth and wavelength tunability with in-band ripple control is demonstrated by thermally tuning the resonance offset between the two microring resonators.
Carrier Lifetimes in Fluorescent 6H-SiC for LEDs Application

Recently it was shown a new approach based on all-semiconductor material technology which is composed with a near ultra-violet GaN LED excitation source and fluorescent silicon carbide (f-6H-SiC) substrate which generates a visible broad spectral light by N and B dopants and an efficient donor to acceptor pair recombination [1,2]. This combination can achieve higher electric-light conversion efficiency and high color rendering in comparison with today’s used blue GaN LED based and phosphors. The devices are promising candidates for general lighting applications and may obtain stability/reproducibility, and potentially low cost in high performance LEDs. However, there are still many problems to obtain best optimization for f-6H-SiC material since neither carrier transport, nor the carrier recombination is known in such co-doped carbides. From the existing data of carrier lifetimes in the SiC materials it is impossible to calculate requirements for epilayer thicknesses, for surfaces and interfaces that can provide sink for non-intentional losses of emission probability. In this work we report on carrier lifetime studies in f-6H-SiC epitaxial growth layers that are co-doped by N and B impurities. Epitaxial samples were grown by a sublimation growth process using a control of source materials. Variable concentration of B and N dopants was uniform over epitaxial thicknesses 45-60 m as was obtained by SIMS measurements (Table 1). Samples had different PL intensity at 300 K. Free-carrier-absorption technique under co-linear and orthogonal probe geometry was used to measure carrier lifetimes in the layers under variable injection conditions. Same results are shown in Fig. 1 exaggerating the fact that longer electron lifetime responsible for higher emission and n-type doping should prevail the p-type doping in active layer of 6H-SiC. An appropriate model for explaining experimental findings will be presented together with an appropriate model for the LED device.

Characterization of donor-acceptor-pair emission in fluorescent 6H-SiC

Boron (B)- and nitrogen (N)-codoped 6H-SiC epilayer exhibits strong donor to acceptor pair (DAP) band luminescence which makes it a promising candidate for the white light emitting diode (LED) [1]. To investigate the optimized dopant concentrations, five samples with the same B concentration level and varies N concentrations were grown by the fast sublimation growth process (FSGP) and analyzed by the photoluminescence (PL) and angle-resolved PL measurements. Secondary ion mass spectrometry (SIMS) and Raman spectroscopy confirm the increasing N concentration from sample #a to #e [2]. The PL spectra are shown in Fig. 1. It is seen that high-level p-type sample (#a) exhibits extremely low DAP emission efficiency, while low-level p-type samples (#b, #c) have relatively stronger DAP emission but still at a low level.
Intense DAP emission was observed in n-type samples (d, e) and the strongest DAP emission occurred in sample d with B and N concentration difference of $4.6 \times 10^{18}$ cm$^{-3}$. Despite the intensity difference, all the DAP emission spectra show the same peak wavelength at 584 nm and with a full width at half maximum (FWHM) of 120 nm. From Fig. 2, it is shown that the peak wavelength blue shifts with increasing emission angle in sample d, and the FWHM starts to decrease and becomes more dramatic when the emission angle is larger than 45 degrees. Our results revealed that the optimized way to achieve intense DAP emission in B-N-doped 6H-SiC is to use low-level n-type doping with both B and N concentrations exceeding $10^{18}$ cm$^{-3}$. Also, the their difference should be larger than $4 \times 10^{18}$ cm$^{-3}$.

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Organisations: Nanophotonic Devices, Department of Photonics Engineering, Linköping University, KTH - Royal Institute of Technology
Authors: Ou, Y. (Intern), Jokubavicius, V. (Ekstern), Linnarsson, M. (Ekstern), Yakimova, R. (Ekstern), Syväjärvi, M. (Ekstern), Ou, H. (Intern)
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Donor-acceptor-pair emission characterization in N-B doped fluorescent SiC
In the present work, we investigated donor-acceptor-pair emission in N-B doped fluorescent 6H-SiC, by means of photoluminescence, Raman spectroscopy, and angle-resolved photoluminescence. The photoluminescence results were interpreted by using a band diagram with Fermi-Dirac statistics. It is shown that with N and B concentrations in a range of $10^{18}$ cm$^{-3}$ the samples exhibit the most intense luminescence when the concentration difference (n-type) is about $4.6 \times 10^{18}$ cm$^{-3}$. Raman spectroscopy studies further verified the doping type and concentrations for the samples. Furthermore, strong luminescence intensity in a large emission angle range was achieved from angle-resolved photoluminescence. The results indicate N-B doped fluorescent SiC as a good wavelength converter in white LEDs applications.

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Formation and characterization of varied size germanium nanocrystals by electron microscopy, Raman spectroscopy, and photoluminescence

Germanium nanocrystals are being extensively examined. Their unique optical properties (brought about by the quantum confinement effect) could potentially be applied in wide areas of nonlinear optics, light emission and solid state memory etc. In this paper, Ge nanocrystals embedded in a SiO2 matrix were formed by complementary metal-oxide-semiconductor compatible technology, e.g. plasma enhanced chemical vapour deposition and annealing. Different sizes of the Ge nanocrystals were prepared and analyzed by transmission electron microscopy with respect to their size, distribution and crystallization. The samples of different size Ge nanocrystals embedded in the SiO2 matrix were characterized by Raman spectroscopy and photoluminescence. Interplayed size and strain effect of Ge nanocrystals was demonstrated by Raman spectroscopy after excluding the thermal effect with proper excitation laser power. It was clarified that two strong emission peaks at 3.19 eV and 4.40 eV are from the interface between Ge nanocrystals and SiO2 matrix.

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Generation of a 640 Gbit/s NRZ OTDM signal using a silicon microring resonator

A 640 Gbit/s NRZ OTDM signal has been successfully generated for the first time by format conversion of a 640 Gbit/s OTDM signal from RZ to NRZ. First, a coherent 640 Gbit/s OTDM RZ signal is generated by wavelength conversion of the original incoherent OTDM signal utilizing Kerr switching in a highly nonlinear fiber. Second, RZ-to-NRZ format conversion is achieved in a specially designed silicon microring resonator with FSR of 1280 GHz, Q value of 638, high extinction ratio and low coupling loss to optical fiber. A 640 Gbit/s NRZ OTDM signal with very clear eye-diagram and narrower bandwidth than both the original incoherent 640 Gbit/s and the wavelength converted coherent 640 Gbit/s RZ OTDM signals has been obtained. Bit error ratio measurements show error free (}
Geometrical control of 3C and 6H-SiC nucleation on low off-axis substrates

Growth of 3C or 6H-SiC epilayers on low off-axis 6H-SiC substrates can be mastered by changing the size of the on axis plane formed by long terraces in the epilayer using geometrical control. The desired polytype can be selected in thick (~200 μm) layers of both 6H-SiC and 3C-SiC polytypes on substrates with off-orientation as low as 1.4 and 2 degrees. The resultant crystal quality of the 3C and the 6H-SiC epilayers, grown under the same process parameters, deteriorates when lowering the off-orientation of the substrate.
Multi-Channel 40 Gbit/s NRZ-DPSK Demodulation Using a Single Silicon Microring Resonator

We comprehensively analyze the demodulation of wavelength division multiplexed (WDM) non return-to-zero differential phase-shift keying (NRZ-DPSK) signals by a single microring resonator. Simultaneous demodulation of multiple 40 Gbit/s WDM NRZ-DPSK channels is demonstrated using a single silicon microring resonator with free spectral range (FSR) of 100 GHz. Bit error measurements show very good performance for both through and drop port demodulations for all
channels, and the drop port demodulation exhibits better wavelength detuning tolerance than for demodulation using a Mach-Zehnder delay interferometer (MZDI).

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ISI indexed (2012): ISI indexed yes
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ISI indexed (2011): ISI indexed yes
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BFI (2010): BFI-level 2
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Web of Science (2008): Indexed yes
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Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 2.149 SNIP 2.603
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 2.939 SNIP 3.016
Web of Science (2005): Indexed yes
Photoluminescence and Raman spectroscopy characterization of boron- and nitrogen-doped 6H silicon carbide

Boron- and nitrogen-doped 6H silicon carbide epilayers grown on low off-axis 6H silicon carbide substrates have been characterized by photoluminescence and Raman spectroscopy. Combined with secondary ion mass spectrometry results, preferable doping type and optimized concentration could be proposed to obtain strong donor to acceptor pair band luminescence.

Size-effect of germanium nanocrystals

Different sizes of Ge nanocrystals embedded in a SiO2 matrix were formed by PECVD, and analyzed by TEM. Size effect of Ge nanocrystals was demonstrated by Raman spectroscopy after excluding the thermal effect.
Towards Polarization Diversity on the SOI Platform With Simple Fabrication Process

We present a polarization diversity circuit built on the silicon-on-insulator (SOI) platform, which can be fabricated by a simple process. The polarization diversity is based on two identical air-clad asymmetrical directional couplers, which simultaneously play the roles of polarization splitter and rotator. A silicon polarization diversity circuit with a single microring resonator is fabricated on the SOI platform. Only 1-dB polarization-dependent loss is demonstrated. A significant improvement of the polarization dependence is obtained for 20-Gb/s nonreturn-to-zero differential phase-shift keying (NRZ-DPSK) demodulation using the polarization diversity circuit, compared to a single microring resonator without polarization diversity.
We demonstrate tunable microwave phase shifters based on electrically tunable silicon-on-insulator dual-microring resonators. A quasi-linear phase shift of 360° with ~2dB radio frequency power variation at a microwave frequency of 40GHz is obtained.
All-optical tunable photonic crystal cavity

We demonstrate an ultra-small photonic crystal cavity with two resonant modes. An all-optical tuning operation based on the free-carrier plasma effect is, for the first time, realized utilizing a continuous wave light source. The thermo-optical effect is minimized by isopropanol infiltration of the photonic crystal structure.

Bandwidth tunable filter based on silicon microring-MZI structure

A novel bandwidth tunable bandpass filter based on a silicon microring-MZI structure is proposed and demonstrated. By thermally tuning the resonance offset between the two microring resonators, and adding the two drop transmissions together, the bandwidth of the microring-MZI filter can be easily linearly tuned with low in-band ripples.
Microwave photonic phase shifter based on tunable silicon-on-insulator microring resonator
We demonstrate a microwave photonic phase shifter based on an electrically tunable silicon-on-insulator microring resonator. A continuously tunable phase shift of up to 315° at a microwave frequency of 15GHz is obtained.

Multi-Channel 40 Gbit/s NRZ-DPSK demodulation using a single silicon microring resonator
We demonstrate simultaneous demodulation of multiple 40 Gbit/s WDM NRZ-DPSK channels using a single silicon microring resonator with FSR of 100 GHz. Bit error measurements show very good performances for both through and drop demodulations for all channels.
Multi-channel WDM RZ-to-NRZ format conversion at 50 Gbit/s based on single silicon microring resonator

We comprehensively analyze multiple WDM channels RZ-to-NRZ format conversion using a single microring resonator. The scheme relies on simultaneous suppression of the first order harmonic components in the spectra of all the RZ channels. An optimized silicon microring resonator with free spectral range of 100 GHz and Q value of 7900 is designed and fabricated for this purpose. Multi-channel RZ-to-NRZ format conversion is demonstrated experimentally at 50 Gbit/s for WDM channels with 200 GHz channel spacing using the fabricated device. Bit error rate (BER) measurements show very good conversion performances for the scheme.
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 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.
'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 Porphyria patient.

RZ-to-NRZ format conversion at 50 Gbit/s based on a silicon microring resonator
We demonstrate RZ-to-NRZ format conversion at 50 Gbit/s based on silicon microring resonator with FSR of 100 GHz. Bit error rate measurements show a low power penalty compared to electrical NRZ signal for error free operation.
Silicon-on-insulator ring-shaped photonic crystal waveguides for refractive index sensing

General information
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Topology-optimized slow-light couplers for ring-shaped photonic crystal waveguide
We demonstrate a topology-optimized coupler for a ring-shaped photonic crystal waveguide to improve the coupling of light located in the slow-light regime. An enhancement of the coupling efficiency of up to 2.5 dB is experimentally demonstrated.

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Tunable microwave phase shifter based on silicon-on-insulator microring resonator

We demonstrate microwave phase shifters based on electrically tunable silicon-on-insulator microring resonators (MRRs). MRRs with different quality factors are fabricated and tested. A continuously tunable phase shift of up to 336 at a microwave frequency of 40 GHz is obtained using a high-quality-factor (28 000) MRR with only 1.6-mW power consumption. A quasi-linear phase shift in the range of 0 – 204 at 40 GHz with a radio-frequency power variation less than 1.3 dB is also achieved by using a lower-quality-factor MRR.

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Web of Science (2015): Indexed yes
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Scopus rating (2014): SJR 1.461 SNIP 1.614 CiteScore 2.78
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Scopus rating (2013): SJR 1.487 SNIP 1.547 CiteScore 2.95
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.623 SNIP 1.706 CiteScore 2.46
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.51 SNIP 2.012 CiteScore 2.48
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.474 SNIP 1.623
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.775 SNIP 1.804
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 2.081 SNIP 1.818
Ultra-low-loss inverted taper coupler for silicon-on-insulator ridge waveguide

An ultra-low-loss coupler for interfacing a silicon-on-insulator ridge waveguide and a single-mode fiber in both polarizations is presented. The inverted taper coupler, embedded in a polymer waveguide, is optimized for both the transverse-magnetic and transverse-electric modes through tapering the width of the silicon-on-insulator waveguide from 450 nm down to less than 15 nm applying a thermal oxidation process. Two inverted taper couplers are integrated with a 3-mm long silicon-on-insulator ridge waveguide in the fabricated sample. The measured coupling losses of the inverted taper coupler for transverse-magnetic and transverse-electric modes are ~0.36 dB and ~0.66 dB per connection, respectively.
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Web of Science (2016): Indexed yes
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Scopus rating (2015): SJR 0.711 SNIP 0.987 CiteScore 1.62
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BFI (2014): BFI-level 2
Scopus rating (2014): SJR 0.719 SNIP 1.058 CiteScore 1.62
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 0.746 SNIP 1.058 CiteScore 1.78
ISI indexed (2013): ISI indexed yes
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BFI (2009): BFI-level 2
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Scopus rating (2008): SJR 1.139 SNIP 1.24
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.069 SNIP 1.069
Web of Science (2007): Indexed yes
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Scopus rating (2005): SJR 1.239 SNIP 1.363
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Scopus rating (2004): SJR 1.281 SNIP 1.407
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Ultra-low loss nano-taper coupler for Silicon-on-Insulator ridge waveguide

A nano-taper coupler is optimized specially for the transverse-magnetic mode for interfacing light between a silicon-on-insulator ridge waveguide and a single-mode fiber. An ultra-low coupling loss of ~0.36dB is achieved for the nano-taper coupler.

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Widely tunable microwave phase shifter based on silicon-on-insulator dual-microring resonator

We propose and demonstrate tunable microwave phase shifters based on electrically tunable silicon-on-insulator microring resonators. The phase-shifting range and the RF-power variation are analyzed. A maximum phase-shifting range of 0~600° is achieved by utilizing a dual-microring resonator. A quasi-linear phase shift of 360° with RF-power variation lower than 2dB and a continuous 270° phase shift without RF-power variation at a microwave frequency of 40GHz are also demonstrated.

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Scopus rating (2013): SJR 2.358 SNIP 2.226 CiteScore 4.38
Fabrication of Ge nanocrystals doped silica-on-silicon waveguides and observation of their strong quantum confinement effect

Germanium (Ge) nanocrystals embedded in silica matrix is an interesting material for new optoelectronic devices. In this paper, standard silica-on-silicon waveguides with a core doped by Ge nanocrystals were fabricated using plasma enhanced chemical vapour deposition and reactive ion etching. The cross-sectional waveguide structures were investigated by scanning electron microscopy. Transmission of the waveguide was measured using a broadband light source.
source covering the wavelength range from 500 nm to 1700 nm, and the results were compared against transmission through a standard waveguide. Strong absorption peaks at 1056.8 nm, 1263.2 nm and 1406 nm were observed. These are assigned to the quantum confinement effect in Ge nanocrystals in the core. Putting Ge nanocrystals in a waveguide enables easy material characterisation and potential application in an integrated lightwave circuit device. PACS 42.82.-m · 42.50.-p · 1.07.Ta

**General information**

**State:** Published

**Organisations:** Diode Lasers and LED Systems, Department of Photonics Engineering, Fiber Optics, Devices and Non-linear Effects

**Authors:** Ou, H. (Intern), Rottwitt, K. (Intern)

**Pages:** 57-60

**Publication date:** 2009

**Main Research Area:** Technical/natural sciences

**Publication information**

**Journal:** Applied Physics B

**Volume:** 96

**Issue number:** 1

**ISSN (Print):** 0946-2171

**Ratings:**

BFI (2017): BFI-level 1

Web of Science (2017): Indexed Yes

BFI (2016): BFI-level 1

Scopus rating (2016): SJR 0.801 SNIP 1.058 CiteScore 1.91

BFI (2015): BFI-level 1

Scopus rating (2015): SJR 0.931 SNIP 1.112 CiteScore 1.74

Web of Science (2015): Indexed yes

BFI (2014): BFI-level 1

Scopus rating (2014): SJR 1.089 SNIP 1.256 CiteScore 1.96

BFI (2013): BFI-level 1

Scopus rating (2013): SJR 1.04 SNIP 1.181 CiteScore 1.92

ISI indexed (2013): ISI indexed yes

Web of Science (2013): Indexed yes

BFI (2012): BFI-level 1

Scopus rating (2012): SJR 1.212 SNIP 1.252 CiteScore 1.88

ISI indexed (2012): ISI indexed yes

Web of Science (2012): Indexed yes

BFI (2011): BFI-level 1

Scopus rating (2011): SJR 1.329 SNIP 1.566 CiteScore 2.34

ISI indexed (2011): ISI indexed yes

Web of Science (2011): Indexed yes

BFI (2010): BFI-level 1

Scopus rating (2010): SJR 1.458 SNIP 1.515

Web of Science (2010): Indexed yes

BFI (2009): BFI-level 1

Scopus rating (2009): SJR 1.582 SNIP 1.661

Web of Science (2009): Indexed yes

BFI (2008): BFI-level 1

Scopus rating (2008): SJR 1.766 SNIP 1.507

Web of Science (2008): Indexed yes

Scopus rating (2007): SJR 1.72 SNIP 1.378

Web of Science (2007): Indexed yes

Scopus rating (2006): SJR 1.479 SNIP 1.31

Web of Science (2006): Indexed yes

Scopus rating (2005): SJR 1.635 SNIP 1.385

Web of Science (2005): Indexed yes
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.

General information
State: Published
Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems
Authors: Corell, D. D. (Intern), Ou, H. (Intern), Dam-Hansen, C. (Intern), Petersen, P. M. (Intern), Friis, D. (Ekstern)
Pages: 17293-17302
Publication date: 2009
Main Research Area: Technical/natural sciences

Publication information
Journal: Optics Express
Volume: 17
Issue number: 20
ISSN (Print): 1094-4087
Ratings:
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.48 SJR 1.487 SNIP 1.589
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.976 SNIP 1.755 CiteScore 3.78
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.349 SNIP 2.166 CiteScore 4.18
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.358 SNIP 2.226 CiteScore 4.38
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.587 SNIP 2.145 CiteScore 3.85
ISI indexed (2012): ISI indexed yes
Low insertion loss SOI microring resonator integrated with nano-taper couplers

We demonstrate a microring resonator working at TM mode integrated with nano-taper couplers with 3.6dB total insertion loss. The measured insertion loss of the nano-taper coupler was only 1.3dB for TM mode.

General information
State: Published
Organisations: Nanophotonic Devices, Department of Photonics Engineering, Diode Lasers and LED Systems, Nanophotonics Theory and Signal Processing
Authors: Pu, M. (Intern), Frandsen, L. H. (Intern), Ou, H. (Intern), Yvind, K. (Intern), Hvam, J. M. (Intern)
Publication date: 2009
New light with diodes: light for a brighter future

**General information**
State: Published
Organisations: Diode Lasers and LED Systems, Department of Photonics Engineering
Number of pages: 267
Pages: 169-187
Publication date: 2009

**Host publication information**
Title of host publication: Beyond optical horizons : today and tomorrow with photonics
Place of publication: Kgs. Lyngby
Publisher: DTU Fotonik
ISBN (Print): 87-92062-34-2
Main Research Area: Technical/natural sciences
Source-ID: 255188
Publication: Communication › Book chapter – Annual report year: 2009

Fabrication of Ge Nanocrystals Doped Silica-on-Silicon Waveguides and Observation of Their Strong Quantum Confinement Effect

Standard silica-on-silicon waveguides with a core doped by Ge nanocrystals were fabricated using PECVD and RIE. Transmission of the waveguide was measured, and strong absorption peaks at 1056.8 nm, 1406 nm and 1263.2 nm were observed.

**General information**
State: Published
Organisations: Diode Lasers and LED Systems, Department of Photonics Engineering, Fiber Optics, Devices and Nonlinear Effects
Authors: Ou, H. (Intern), Rottwitt, K. (Intern)
Pages: 119-120
Publication date: 2008

**Host publication information**
Title of host publication: 21th Annual Lasers and Electro Optics Society Meeting
Publisher: IEEE Press
Main Research Area: Technical/natural sciences
Electronic versions:
Ou.pdf
DOI: 10.1109/LEOS.2008.4688517

**Bibliographical note**
Copyright: 2008 IEEE. Personal use of this material is permitted. However, permission to reprint/republish this material for advertising or promotional purposes or for creating new collective works for resale or redistribution to servers or lists, or to reuse any copyrighted component of this work in other works must be obtained from the IEEE
Source: orbit
Source-ID: 229170
Publication: Research - peer-review › Article in proceedings – Annual report year: 2008
Ge nanoclusters in PECVD-deposited glass caused only by heat treatment

This paper reports the formation of Ge nanoclusters in a multi-layer structure consisting of alternating thin films of Ge-doped silica glass and SiGe, deposited by plasma-enhanced chemical vapor deposition (PECVD) and post annealed at 1100 °C in N2 atmosphere. We studied the annealed samples by transmission electron microscopy (TEM) and Raman spectroscopy. As-deposited and annealed samples were analyzed by secondary ion mass spectroscopy (SIMS). TEM investigation shows that Ge nanoclusters were formed in the as-deposited SiGe layer and the SiGe layer was transformed into a silicon dioxide layer embedded with Ge nanoclusters after annealing. These nanoclusters are crystalline and varied in size. There were no clusters in the Ge-doped glass layer. Raman spectra verified the existence of crystalline Ge clusters. The positional shift of the Ge vibrational peak with the change of the focus depth indicates that the distribution of the stress applied to the Ge clusters varies with depth. SIMS measurements show clearly the dramatic O increase in the as-deposited SiGe layer after annealing. The creation of Ge nanoclusters by the combination of PECVD and annealing makes possible the application in complicated waveguide components.
Ge nanoclusters in PECVD-deposited glass after heat treating and electron irradiation

This paper reports the formation of Ge nanoclusters in silica glass thin films deposited by plasma-enhanced chemical vapor deposition (PECVD). We studied the samples by transmission electron microscopy (TEM) and Raman spectroscopy after annealing. TEM investigation shows that the Ge nanoclusters at two areas were formed by different mechanisms. The Ge nanoclusters formed in a single row along the interface of a silicon substrate and the silica glass film by annealing during high-temperature heat treatment. Ge nanoclusters did not initially form in the bulk of the film but could be subsequently formed by the electron-beam irradiation. The interface between the silicon substrate and the silica glass film was investigated by Raman spectroscopy. The shift of the Raman peaks around 286.8 cm\(^{-1}\) and 495 cm\(^{-1}\) suggests that the interface is a Si\(^{1-x}\)Ge\(^x\) alloy film and that the composition \(x\) varies along the film growth direction.

General information

State: Published
Organisations: Fibers & Nonlinear Optics, Department of Photonics Engineering, Department of Management Engineering, Energy and Materials, Department of Chemistry
Authors: Ou, H. (Intern), Rørdam, T. P. (Intern), Rottwitt, K. (Intern), Grumsen, F. B. (Intern), Horsewell, A. (Intern), Berg, R. W. (Intern)
Pages: 327-331
Publication date: 2007
Main Research Area: Technical/natural sciences

Publication information
Journal: Applied Physics B
Volume: 87
Issue number: 2
ISSN (Print): 0946-2171
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.801 SNIP 1.058 CiteScore 1.91
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.931 SNIP 1.112 CiteScore 1.74
Ge-nanostructures doped silica-on-silicon waveguides

General information
State: Published
Organisations: Department of Photonics Engineering, Fibers & Nonlinear Optics
Authors: Ou, H. (Intern), Rørdam, T. P. (Intern), Rottwitt, K. (Intern), Grumsen, F. (Ekstern), Horsewell, A. (Ekstern), Berg, R. W. (Ekstern)
Ultra-compact silica-on-silicon microresonators by etching deep trenches

General information
State: Published
Organisations: Fibers & Nonlinear Optics, Department of Photonics Engineering
Authors: Ou, H. (Intern), Rottwitt, K. (Intern), Philipp, H. T. (Intern)
Number of pages: 1
Pages: WB3
Publication date: 2007

Host publication information
Title of host publication: ECIO proceedings
Place of publication: Kgs. Lyngby
Publisher: COM.DTU
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 199198
Publication: Research - peer-review › Article in proceedings – Annual report year: 2007

A Generic Lightwave Integrated Chip (GLIC) for fast high-resolution wavelength monitoring

General information
State: Published
Organisations: Fibers & Nonlinear Optics, Department of Photonics Engineering
Authors: Ging, J. (Ekstern), Larkin, A. (Ekstern), O’Dowd, R. (Ekstern), Haiyan, O. (Intern), Rottwitt, K. (Intern)
Pages: 6183-02
Publication date: 2006

Host publication information
Title of host publication: Proceedings Photonics Europe
Place of publication: Strasbourg, France
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 189557
Publication: Research - peer-review › Article in proceedings – Annual report year: 2006

Deep glass etched microring resonators based on silica-on-silicon technology
Microring resonators fabricated on silica-on-silicon technology using deep glass etching are demonstrated. The fabrication procedures are introduced and the transmission spectrum of a resonator is presented.

General information
State: Published
Organisations: Fibers & Nonlinear Optics, Department of Photonics Engineering
Authors: Ou, H. (Intern), Rottwitt, K. (Intern), Philipp, H. T. (Intern)
Pages: 581-583
Publication date: 2006
Main Research Area: Technical/natural sciences

Publication information
Journal: Electronics Letters
Volume: 42
Ge-nanoclusters were formed by electron-beam irradiation in Ge-doped silica-on-silicon thin films. The size and density of the clusters can be controlled by the irradiation intensity and time.

General information
State: Published
Organisations: Fibers & Nonlinear Optics, Department of Photonics Engineering, Department of Management Engineering, Center for Nanoteknologi
Authors: Ou, H. (Intern), Rørdam, T. P. (Intern), Rottwitt, K. (Intern), Grumsen, F. B. (Intern), Horsewell, A. (Intern)
Pages: 532-534
Publication date: 2006
Main Research Area: Technical/natural sciences

Publication information
Journal: ELECTRONICS LETTERS
Volume: 42
Issue number: 9
ISSN (Print): 0013-5194
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.442 SNIP 0.882 CiteScore 1.35
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.497 SNIP 1.011 CiteScore 1.31
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.522 SNIP 1.061 CiteScore 1.31
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.59 SNIP 1.155 CiteScore 1.45
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.631 SNIP 1.161 CiteScore 1.45
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.634 SNIP 1.098 CiteScore 1.44
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.637 SNIP 1.011
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.728 SNIP 1.072
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 0.843 SNIP 0.957
Web of Science (2008): Indexed yes
Novel deep glass etched microring resonators based on silica-on-silicon technology

General information
State: Published
Organisations: Fibers & Nonlinear Optics, Department of Photonics Engineering
Authors: Ou, H. (Intern), Rottwitt, K. (Intern), Philipp, H. T. (Intern)
Publication date: 2006
Event: Abstract from Integrated Photonics Research and Applications, Topical meeting or the Nanophotonics Topical Meeting, Uncasville, Connecticut, USA.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 190506
Publication: Research - peer-review › Journal article – Annual report year: 2006

Strained silicon as a new electro-optic material

For decades, silicon has been the material of choice for mass fabrication of electronics. This is in contrast to photonics, where passive optical components in silicon have only recently been realized1, 2. The slow progress within silicon optoelectronics, where electronic and optical functionalities can be integrated into monolithic components based on the versatile silicon platform, is due to the limited active optical properties of silicon3. Recently, however, a continuous-wave Raman silicon laser was demonstrated4; if an effective modulator could also be realized in silicon, data processing and transmission could potentially be performed by all-silicon electronic and optical components. Here we have discovered that a significant linear electro-optic effect is induced in silicon by breaking the crystal symmetry. The symmetry is broken by depositing a straining layer on top of a silicon waveguide, and the induced nonlinear coefficient, (2) 15 pm V-1, makes it possible to realize a silicon electro-optic modulator. The strain-induced linear electro-optic effect may be used to remove a bottleneck in modern computers by replacing the electronic bus with a much faster optical alternative.

General information
State: Published
Organisations: Department of Photonics Engineering, Department of Micro- and Nanotechnology, Fibers & Nonlinear Optics, Systems Center for Nanoteknologi, Center for Individual Nanoparticle Functionality
Pages: 199-202
Publication date: 2006
Main Research Area: Technical/natural sciences
Deep silica and silicon etching in silica-on-silicon waveguide technology

General information
State: Published
Organisations: Fibers & Nonlinear Optics, Department of Photonics Engineering
Authors: Ou, H. (Intern), Rottwitt, K. (Intern)
Pages: 518-521
Ge-Nanoclusters embedded in Ge-doped silica-on-silicon waveguides

General information
State: Published
Organisations: Fibers & Nonlinear Optics, Department of Photonics Engineering
Authors: Ou, H. (Intern), Rørdam, T. P. (Intern), Rottwitt, K. (Intern), Grumsen, F. (Ekstern), Horsewell, A. (Ekstern)
Publication date: 2005
Event: Abstract from Integrated Photonics Research and Applications Topical Meeting, San Diego, California, USA.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 183164
Publication: Research › Conference abstract for conference – Annual report year: 2005

Nonlinear germanium nanocluster doped planar waveguides

General information
State: Published
Organisations: Fibers & Nonlinear Optics, Department of Photonics Engineering
Authors: Rottwitt, K. (Intern), Ou, H. (Intern), Wandel, M. E. (Intern)
Publication date: 2005

Amorphous silicon rich silicon nitride optical waveguides for high density integrated optics
Amorphous silicon rich silicon nitride optical waveguides clad in silica are presented as a high-index contrast platform for high density integrated optics. Performance of different cross-sectional geometries have been measured and are presented with regards to bending loss and insertion loss. A sample double ring add-drop filter is presented.

General information
State: Published
Organisations: Glass Components and Materials, Department of Photonics Engineering, Department of Micro- and Nanotechnology
Authors: Philipp, H. T. (Ekstern), Andersen, K. N. (Intern), Svendsen, W. E. (Intern), Haiyan, O. (Intern)
Pages: 419-420
Publication date: 2004
Main Research Area: Technical/natural sciences

Publication information
Journal: Electronics Letters
Volume: 40
Issue number: 7
ISSN (Print): 0013-5194
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Burned photoresist is used as etch mask when producing silica-on-silicon waveguides. The sidewall angle of the optical glass waveguides is engineered by varying photoresist thickness and etch selectivity. The principle for the formation of the angles is introduced and very promising experimental results are shown.
Germanium (Ge) has been widely used as the dopant in the core layer of planar glass waveguides to increase the refractive index because it gives a small propagation loss. Plasma enhanced chemical vapour deposition (PECVD) and flame hydrolysis deposition (FHD) are two main material deposition methods for waveguide components. For the first time to our best knowledge, this paper reports the formation of Ge nanoclusters in glass thin films deposited by using PECVD. Ge nanoclusters in glass have been demonstrated to have great potential for application to the nonlinear waveguide components. In this work we study the size and distribution of the nanoclusters by transmission electron microscopy (TEM) and Raman spectroscopy. The formation of the clusters is investigated by varying the Ge concentration in the glass and changing the annealing conditions such as temperature, atmosphere and time. The combined effect of a strong nonlinear glass material and a material platform that is well known from standard planar lightwave components makes this Ge nanoclusters material very promising for optical nonlinear waveguide components that are readily fabricated by using the same processing as standard waveguide components.

**General information**

State: Published
Organisations: Department of Photonics Engineering, Department of Chemistry
Authors: Haiyan, O. (Intern), Olsen, J. H. (Ekstern), Rottwitt, K. (Intern), Berg, R. W. (Intern)
Number of pages: 7
Publication date: 2004

**Host publication information**

Title of host publication: XX International Congress on Glass : September 26-October 1, 2004
Volume: Published on DVD by the organizers, The Ceramic Society of Japan, Glass Division
Place of publication: Kyoto, Japan
Publisher: Ceramic Society of Japan, Glass Division
Edition: XX

Series: International Congress on Glass
Number: XX
Main Research Area: Technical/natural sciences
Links:
http://www.kemi.dtu.dk/%7Eajo/rolf/kyoto.pdf

**Bibliographical note**

Extended abstract Paper
Source: orbit
Source-ID: 154278
Publication: Research - peer-review › Article in proceedings – Annual report year: 2004

**Ge nanoclusters in planar glass waveguides deposited by PECVD tentative presentation**

**General information**

State: Published
Organisations: Department of Photonics Engineering
Authors: Haiyan, O. (Intern), Olsen, J. H. (Ekstern), Rottwitt, K. (Intern), Berg, R. (Ekstern)
Pages: 1-6
Publication date: 2004

**Host publication information**

Title of host publication: 20th international congress on glass
Low-loss silicon rich silicon nitride waveguides for high density integrated optics

General information
State: Published
Organisations: Department of Photonics Engineering, Department of Micro- and Nanotechnology
Authors: Philipp, H. T. (Intern), Andersen, K. N. (Intern), Svendsen, W. E. (Intern), Haiyan, O. (Intern)
Publication date: 2004
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 155855
Publication: Research - peer-review › Poster – Annual report year: 2004

Low-loss silicon rich silicon nitride waveguides for high density integrated optics

General information
State: Published
Organisations: Nanointegration, Department of Photonics Engineering, Nanophotonic Devices, Nano-Bio Integrated Systems Group, Biomedical Micro Systems Section, Department of Micro- and Nanotechnology
Authors: Dyvelkov, K. N. (Intern), Ou, H. (Intern), Philipp, H. T. (Intern), Svendsen, W. E. (Intern)
Publication date: 2004
Event: Abstract from KIF, .
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 191997
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2004

Orthogonal optical labeling based on a 40 Gbit/s DPSK payload and a 2.5 Gbit/s IM label
We experimentally demonstrate label encoding/erasure and transmission for an orthogonally labeled signal using a 40 Gbit/s DPSK payload and an IM label. The influence of the modulation depth and the label erasure are discussed.

General information
State: Published
Organisations: Systems, Department of Photonics Engineering, Department of Micro- and Nanotechnology, Glass Components and Materials
Authors: Chi, N. (Intern), Xu, L. (Intern), Holm-Nielsen, P. V. (Intern), Peucheret, C. (Intern), Mikkelsen, C. I. (Intern), Haiyan, O. (Intern), Seoane, J. (Intern), Jeppesen, P. (Intern)
Pages: FO6
Publication date: 2004

Host publication information
Title of host publication: Technical Digest Optical Fiber Communication Conference 2004
Volume: 2
Place of publication: USA
Publisher: IEEE
Main Research Area: Technical/natural sciences
Electronic versions:
Chi.pdf
DOIs:
10.1109/OFC.2004.1362265

Bibliographical note
Copyright: 2004 IEEE. Personal use of this material is permitted. However, permission to reprint/republish this material for advertising or promotional purposes or for creating new collective works for resale or redistribution to servers or lists, or to reuse any copyrighted component of this work in other works must be obtained from the IEEE
Trenches for building blocks of advanced planar components

General information
State: Published
Organisations: Department of Photonics Engineering
Authors: Haiyan, O. (Intern), Rottwitt, K. (Intern)
Publication date: 2004
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 155774
Publication: Research - peer-review › Poster – Annual report year: 2004

Trenches for building blocks of advanced planar components

Trenches are fundamental structures used to build advanced optical planar waveguide components. In this letter, the fabrication of trenches across silica-on-silicon waveguides using inductively coupled plasma etching is presented. These trenches were etched deep into the silicon substrate and their widths were varied between 24 and 100 μm.

General information
State: Published
Organisations: Glass Components and Materials, Department of Photonics Engineering
Authors: Haiyan, O. (Intern)
Pages: 1334-1336
Publication date: 2004
Main Research Area: Technical/natural sciences

Publication information
Journal: IEEE Photonics Technology Letters
Volume: 16
Issue number: 5
ISSN (Print): 1041-1135
Ratings:
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.52 SJR 1.018 SNIP 1.279
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.263 SNIP 1.327 CiteScore 2.62
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.461 SNIP 1.614 CiteScore 2.78
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.487 SNIP 1.547 CiteScore 2.95
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.623 SNIP 1.706 CiteScore 2.46
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.51 SNIP 2.012 CiteScore 2.48
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
Different index contrast silica-on-silicon waveguides by PECVD

Ge-doped silica-on-silicon waveguides with index steps of 0.01 and 0.02 were fabricated by a combination of plasma enhanced chemical vapour deposition (PECVD) and reactive ion etching (RIE) techniques, and their characteristics, including propagation loss, coupling loss with standard singlemode fibres, minimal bend radius, and birefringence, were investigated. The waveguides have good propagation properties and small birefringence, compared to using flame hydrolysis deposition (FHD).
A flexible approach for the apodization of planar waveguide Bragg gratings

General information
State: Published
Organisations: Department of Photonics Engineering
Authors: Floreani, F. (Ekstern), Zhang, L. (Ekstern), Deyerl, H. (Intern), Plougmann, N. (Intern), Haiyan, O. (Intern), Jensen, J. B. D. (Intern), Kristensen, M. (Intern)
Pages: 97-99
Publication date: 2003

Host publication information
Title of host publication: BGPP
Main Research Area: Technical/natural sciences
Conference: BGPP, Monterey, CA, United States, 01/01/2003
Source: orbit
Source-ID: 61499

Reactive ion etching in silica-on-silicon planar waveguide technology

General information
State: Published
Organisations: Department of Photonics Engineering
Authors: Haiyan, O. (Intern)
Publication date: 2003

Host publication information
Title of host publication: ECIO
Main Research Area: Technical/natural sciences
Conference: 11th European Conference on Integrated Optics, Prague, Czech Republic, 02/04/2003 - 02/04/2003
Source: orbit
Source-ID: 61555

Transmission and label encoding/erasyro of orthogonally labelled signal using 40 Gbit/s RZ-DPSK payload and 2.5 Gbit/s IM label

General information
State: Published
Organisations: Systems, Department of Photonics Engineering, Department of Micro- and Nanotechnology, Glass Components and Materials
Authors: Chi, N. (Intern), Mikkelsen, C. (Intern), Xu, L. (Intern), Zhang, J. (Intern), Holm-Nielsen, P. V. (Intern), Ou, H. (Intern), Seoane, J. (Intern), Peucheret, C. (Intern), Jeppesen, P. (Intern)
Pages: 1335-1337
Publication date: 2003
Main Research Area: Technical/natural sciences

Publication information
Journal: Electronic Letters
Volume: 39
Issue number: 18
ISSN (Print): 0013-5194
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.442 SNIP 0.882 CiteScore 1.35
Web of Science (2016): Indexed yes
Silica-on-silicon waveguide fabrication

General information
State: Published
Organisations: Department of Photonics Engineering
Authors: Haiyan, O. (Intern), Hübner, J. (Intern)
Projects:

**Nonlinear Silicon Carbide Waveguide**
Department of Photonics Engineering
Period: 15/01/2017 → 14/01/2020
Number of participants: 4
PhD Student:
Zheng, Yi (Intern)
Supervisor:
Hu, Hao (Intern)
Pu, Minhao (Intern)
Main Supervisor:
Ou, Haiyan (Intern)

**Financing sources**
Source: Internal funding (public)
Name of research programme: Samfinansierede - Virksomhed
Project: PhD

**A new type of white-light diode using fluorescent silicon carbide**
Department of Photonics Engineering
Period: 01/09/2015 → 31/08/2018
Number of participants: 2
PhD Student:
Wei, Yi (Intern)
Main Supervisor:
Ou, Haiyan (Intern)

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

**A new type of white light-emitting diode using flourescent silicon carbide**
Department of Photonics Engineering
Period: 01/09/2015 → 31/08/2018
Number of participants: 3
PhD Student:
Lin, Li (Intern)
Supervisor:
Innovative White Light-emitting Diodes Light Source

Department of Photonics Engineering
Period: 01/09/2014 → 31/08/2017
Number of participants: 7
Phd Student:
Lu, Weifang (Intern)
Supervisor:
Ou, Yiyu (Intern)
Petersen, Paul Michael (Intern)
Main Supervisor:
Ou, Haiyan (Intern)
Examiner:
Jensen, Flemming (Intern)
Chaussende, Didier (Ekstern)
Friedel, Bettina (Ekstern)

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

Dispersion Engineered Silicon Photonic Wires for Signal Processing

Department of Photonics Engineering
Period: 01/10/2013 → 26/09/2017
Number of participants: 7
Phd Student:
Mitrovic, Miranda (Intern)
Supervisor:
Guan, Xiaowei (Intern)
Oxenløwe, Leif Katsuo (Intern)
Main Supervisor:
Frandsen, Lars Hagedorn (Intern)
Examiner:
Ou, Haiyan (Intern)
Moss, David J. (Ekstern)
Sciancalepore, Corrado (Ekstern)

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

Black silicon carbide
Proof of concept project

Department of Photonics Engineering
Diode Lasers and LED Systems
Period: 01/09/2012 → 31/08/2013
Number of participants: 2
SiC, nanofabrication
Project participant:
Argyraki, Aikaterini (Intern)
Ou, Haiyan (Intern)

Relations
Activities:
39th International Conference on Micro and Nano Engineering
Fabrication of antireflective SiC surface using plasma etching with self-assembled nanopattern
MNE 2013 Micro Nano Graph Contest, honorable mention

Black silicon carbide
Department of Photonics Engineering
Diode Lasers and LED Systems
Period: 01/08/2012 → 31/07/2013
Number of participants: 1
Project ID: 70581
Project participant:
Ou, Haiyan (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Research programme - DTU project Proof of concept
Amount: 750,000.00 Danish Kroner
Year of approval: 2012

Super bright light-emitting diode using nanophotonics
Super bright (SB) light-emitting diodes (LEDs), representing the most promising future light source to substitute the low energy-efficiency incandescent lamp, is to be achieved in this project by exploring recent advances in nanophotonics, i.e. photonic quasi-crystals (PQC) and surface plasmons (SP). SB LEDs with enhanced efficiency and controlled emission profile will be designed, fabricated and characterized in this project, which will benefit from the collaboration of Chinese and Danish partners with their complementary equipment of expertise. This project gathers top scientists on LED Metal-organic chemical vapour deposition (MOCVD), simulation and modelling of nanostructures for LED efficiency enhancement, nanofabrication and LED characterization. These experts are the most active players in the field of LED from China and Denmark, i.e. Semiconductor Lighting Research and Development Center, Chinese Academy of Science (CAS), Beijing Jiaotong University (BJTU) and Department of Photonics Engineering, Technical University of Denmark (DTU).
In addition, a low-cost nanofabrication method to fabricate this SBLED will be developed with the assistance of NIL Technology APS. The synergy of the overall expertises and resources would help creating a critical mass in this area, thereby placing DTU on the world map in the field of research.

Department of Photonics Engineering
Nanophotonic Devices
Diode Lasers and LED Systems
Nanophotonics Theory and Signal Processing
Period: 01/07/2012 → 30/06/2015
Number of participants: 5
Acronym: SBLED
Project ID: 70702
Project participant:
Dam-Hansen, Carsten (Intern)
Chen, Yuntian (Intern)
Lu, Yanwu (Ekstern)
Wang, Guohong (Ekstern)
Project Manager, academic:
Ou, Haiyan (Intern)

Financing sources
Super bright light-emitting diode

Department of Photonics Engineering
Period: 01/07/2012 → 17/02/2016
Number of participants: 7
Phd Student:
Fadil, Ahmed (Intern)
Supervisor:
Dam-Hansen, Carsten (Intern)
Petersen, Paul Michael (Intern)
Main Supervisor:
Ou, Haiyan (Intern)
Examiner:
Schmidt, Michael Stenbæk (Intern)
Ohkawa, Kazuhiro (Ekstern)
Paiella, Roberto (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Forskningsrådsfinansiering

Relations
Activities:
Danish national CIE committee (External organisation)
Publications:
Application of Surface Plasmonics for Semiconductor Light-Emitting Diodes
Project: PhD

Plasmon-based Light-Emitting Diodes

Department of Photonics Engineering
Period: 15/03/2011 → 14/03/2013
Number of participants: 3
Project ID: 70665
Contact person:
Ou, Haiyan (Intern)
Mark, Jesper (Intern)
Project Manager, organisational:
Chen, Yuntian (Intern)

Financing sources
Source: Forskningsrådene - Andre
Name of research programme: Forskningsrådene - Andre
Amount: 2,016,000.00 Danish Kroner

Metal nanocrystal enhanced thin film solar cells

Department of Photonics Engineering
Period: 15/01/2011 → 12/12/2014
Number of participants: 7
Phd Student:
Gritti, Claudia (Intern)
Supervisor:
Kardynal, Beata (Intern)
To date, the most promising technology for illumination market to replace conventional lighting sources is white Light Emitting Diodes (LEDs). However, this technology is in an initial stage towards commercialization for general illumination market and the production of conventional white LEDs is highly energy consuming and employs hazardous chemicals for humans and the environment. In order to bring white LEDs to the general illumination market there is a need for development of innovative white LED technology leading to improved device functionalities as white light with high energy efficiency, high color quality independent of operating time, temperature, viewing angle, a uniform luminescence and a low production cost. The overall objective of the NORLED project is to develop an innovative and industrially feasible white LED technology overcoming market barriers and meeting consumers requirements. The project develops an innovative white LED structure free of phosphor and which has a highly efficient luminescence with a comfortable light quality to the human eye. More in detailed, technical objectives are: - acquisition of new scientific knowledge in growth of fluorescent SiC material for white LEDs - Production of experimental white emitting diode device with the target luminous flux of 100 lm/w - Evaluation of innovative technology from scientific, economic and social points of view Non-technical project prospective: - Encouragement of scientists mobility in Nordic countries and Germany - Increase of Nordic countries competitiveness in solid state lighting market
**Period:** 01/11/2009 → 31/10/2012

**Number of participants:** 11

**Acronym:** NORLED

**Project participant:**
- Bladh, Mats (Ekstern)
- Söderström, Mats (Ekstern)
- Svendenius, Nils (Ekstern)
- Linnarsson, Margareta (Ekstern)
- Björkman, Marcus (Ekstern)
- Ekman, Johan (Ekstern)
- Ou, Haiyan (Intern)
- Wellmann, Peter (Ekstern)
- Spiecker, Erdmann (Ekstern)
- Wilhite, Harold (Ekstern)

**Project Manager, organisational:**
- Syväjärvi, Mikael (Ekstern)

**Financing sources**
- Source: Forskningsrådene - Andre
- Name of research programme: Forskningsrådene - Andre
- Amount: 2,187,672.00 Danish Kroner

**Coherent detection for optical communication systems**

Department of Photonics Engineering

**Period:** 01/06/2009 → 22/06/2012

**Number of participants:** 7

**Phd Student:**
- Zhang, Xu (Intern)

**Supervisor:**
- Younce, Richard (Ekstern)
- Zibar, Darko (Intern)

**Main Supervisor:**
- Tafur Monroy, Idelfonso (Intern)

**Examiner:**
- Ou, Haiyan (Intern)
- Prat, Josep (Ekstern)
- Siuzdak, Jerzy (Ekstern)

**Financing sources**
- Source: Internal funding (public)
- Name of research programme: 1/3 DTU-stip, 2/3 FUR/andet

**Nano-structured filters**

Department of Photonics Engineering

**Period:** 01/09/2007 → 20/04/2011

**Number of participants:** 7

**Phd Student:**
- Pu, Minhao (Intern)

**Supervisor:**
- Ou, Haiyan (Intern)
- Yvind, Kresten (Intern)

**Main Supervisor:**
- Hvam, Jørn Marcher (Intern)

**Examiner:**
- Kristensen, Anders (Intern)
Borel, Peter Ingo (Intern)
Thourhout, Dries Van (Ekstern)

**Financing sources**
Source: Internal funding (public)
Name of research programme: Programbevilling
Project: PhD

**Activities:**

**Light emitting diodes**
Period: 25 Nov 2010
Haiyan Ou (Speaker)
Department of Photonics Engineering
Nanophotonic Devices

**Description**
Place: Beijing University, Beijing, China

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

**Integrated Optics on silicon substrate**
Period: 23 Nov 2010
Haiyan Ou (Speaker)
Department of Photonics Engineering
Nanophotonic Devices

**Description**
Place: Wuhan, China

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

**Integrated Optics on silicon substrate**
Period: 19 Nov 2010
Haiyan Ou (Speaker)
Department of Photonics Engineering
Nanophotonic Devices

**Description**
Place: Fudan University, Shanghai, China

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

**Integrated optics on silicon substrate**
Period: 17 Nov 2010
Haiyan Ou (Speaker)
Department of Photonics Engineering
Nanophotonic Devices

Description
Place: Yunnan University, Kunming, China

Related external organisation

Unknown external organisation
Activity: Talks and presentations › Conference presentations

Light emitting diodes, yesterday, today and tomorrow
Period: 15 Nov 2010 → 17 Nov 2010
Haiyan Ou (Speaker)
Department of Photonics Engineering
Nanophotonic Devices

Description
Place: Yunnan University, Kunming, China

Related external organisation

Unknown external organisation
Activity: Talks and presentations › Conference presentations

Newlighting-New LEDs
Period: 22 May 2010
Haiyan Ou (Speaker)
Department of Photonics Engineering
Nanophotonic Devices

Description
Place: Chinese Embassy in Denmark, Hellerup

Related external organisation

Unknown external organisation
Activity: Talks and presentations › Conference presentations

Silicon-based Devices in Optical Communication
Period: 17 Mar 2010
Haiyan Ou (Speaker)
Department of Photonics Engineering
Nanophotonic Devices

Description
Place: Stockholm, Sweden

Related external organisation

Unknown external organisation
Activity: Talks and presentations › Conference presentations
Nanophotonic Devices

**Description**
Place: Huazhong University of Sciences and Technology, Wuhan, China

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

**Silicon-based Devices in Optical Communication and Energy Saving**
Period: 1 Aug 2009
Haiyan Ou (Speaker)
Department of Photonics Engineering

Nanophotonic Devices

**Description**
Place: Fudan University, Shanghai, China

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