High-confinement gallium nitride-on-sapphire waveguides for integrated nonlinear photonics

We demonstrate a highly effective nonlinearity of 7.3 W⁻¹m⁻¹ in a high-confinement gallium nitride-on-sapphire waveguide by performing four-wave mixing characterization at telecom wavelengths. Benefitting from a high-index-contrast waveguide layout, we can engineer the device dispersion efficiently and achieve broadband four-wave mixing operation over more than 100 nm. The intrinsic material nonlinearity of gallium nitride is extracted. Furthermore, we fabricate microring resonators with quality factors above 100,000, which will be promising for various nonlinear applications.
**A versatile silicon-silicon nitride photonics platform for enhanced functionalities and applications**

Silicon photonics is one of the most prominent technology platforms for integrated photonics and can support a wide variety of applications. As we move towards a mature industrial core technology, we present the integration of silicon nitride (SiN) material to extend the capabilities of our silicon photonics platform. Depending on the application being targeted, we have developed several integration strategies for the incorporation of SiN. We present these processes, as well as key components for dedicated applications. In particular, we present the use of SiN for athermal multiplexing in optical transceivers for datacom applications, the nonlinear generation of frequency combs in SiN micro-resonators for ultra-high data rate transmission, spectroscopy or metrology applications and the use of SiN to realize optical phased arrays in the 800-1000 nm wavelength range for Light Detection And Ranging (LIDAR) applications. These functionalities are demonstrated using a 200 mm complementary metal-oxide-semiconductor (CMOS)-compatible pilot line, showing the versatility and scalability of the Si-SiN platform.

**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, Université Grenoble Alpes, Ecole Centrale de Lyon  
**Contributors:** Wilmart, Q., El Dirani, H., Tyler, N., Fowler, D., Malhoulitre, S., Garcia, S., Casale, M., Kerdiles, S., Hassan, K., Monat, C., Letartre, X., Kamel, A., Pu, M., Yvind, K., Oxenløwe, L. K., Rabaud, W., Sciancalepore, C., Szelag, B., Olivier, S.

**Number of pages:** 16  
**Publication date:** 11 Jan 2019  
**Peer-reviewed:** Yes

**Publication information**

**Journal:** Applied Sciences (Switzerland)  
**Volume:** 9  
**Issue number:** 2  
**Article number:** 255  
**Keywords:** Beam steering, Coarse Wavelength Division Multiplexing (CWDM), Frequency comb, Grating coupler, Kerr nonlinearity, LIDAR, Multiplexing, Optical phased array, Silicon nitride, Silicon photonics, Transceiver  
**Electronic versions:** HKKR_applsci_09_00255.pdf  
**DOIs:** 10.3390/app9020255

**Research output:** Research - peer-review | Journal article – Annual report year: 2019

**High-Quality-Factor AlGaAs-On-Sapphire Microring Resonators**

We realize an AlGaAs-on-sapphire platform through a Al$_2$O$_3$-assisted direct wafer bonding and substrate removal processes. The direct wafer bonding process is optimized concerning the intermediate layer deposition and annealing temperature to obtain a high bonding strength between the AlGaAs and sapphire wafers. High quality-factor (Q) microring resonators are fabricated using electron-beam lithography in which the charging effect is mitigated by applying an thin aluminum layer and a smooth pattern sidewall definition is obtained using a multi-pass (exposure) process. We achieve an intrinsic Q of up to 460,000, which is the highest Q for AlGaAs microring resonators. Taking advantage of such high Q resonators, we demonstrate an ultra-efficient nonlinear four-wave mixing process in this platform and obtain a conversion efficiency of -19.8 dB with continuous-wave pumping at a power level of 380 μW. We also investigate the thermal resonance shift of microring resonators with different
substrate layouts and observe a superior thermal stability for devices in the AlGaAs-on-sapphire platform. The realization of the AlGaAs-on-sapphire platform also opens new prospects for AlGaAs devices in nonlinear applications in the mid-infrared wavelength range.

**General information**

**State:** Published

**Organisations:** Department of Photonics Engineering, Nanophotonic Devices, Diode Lasers and LED Systems, Centre of Excellence for Silicon Photonics for Optical Communications

**Contributors:** Zheng, Y., Pu, M., Sahoo, H. K., Semenova, E., Yvind, K.

**Number of pages:** 7

**Publication date:** 1 Jan 2018

**Peer-reviewed:** Yes

**Publication information**

**Journal:** Journal of Lightwave Technology

**Volume:** 13

**Issue number:** 9

**ISSN (Print):** 0733-8724

**Ratings:**

- BFI (2019): BFI-level 2
- Web of Science (2019): Indexed yes
- BFI (2018): BFI-level 2
- Web of Science (2018): Indexed yes
- BFI (2017): BFI-level 2
- Scopus rating (2017): CiteScore 4.42 SJR 1.166 SNIP 1.791
- Web of Science (2017): Impact factor 3.652
- Web of Science (2017): Indexed yes
- BFI (2016): BFI-level 2
- Scopus rating (2016): CiteScore 3.87 SJR 1.23 SNIP 1.819
- Web of Science (2016): Indexed yes
- BFI (2015): BFI-level 2
- Scopus rating (2015): CiteScore 4.15 SJR 1.598 SNIP 1.901
- Web of Science (2015): Impact factor 2.567
- Web of Science (2015): Indexed yes
- BFI (2014): BFI-level 2
- Scopus rating (2014): CiteScore 4.23 SJR 1.737 SNIP 2.411
- Web of Science (2014): Impact factor 2.965
- Web of Science (2014): Indexed yes
- BFI (2013): BFI-level 2
- Scopus rating (2013): CiteScore 4.03 SJR 1.622 SNIP 2.439
- Web of Science (2013): Impact factor 2.862
- ISI indexed (2013): ISI indexed yes
- Web of Science (2013): Indexed yes
- BFI (2012): BFI-level 2
- Scopus rating (2012): CiteScore 3.21 SJR 1.888 SNIP 2.491
- Web of Science (2012): Impact factor 2.555
- ISI indexed (2012): ISI indexed yes
- Web of Science (2012): Indexed yes
- BFI (2011): BFI-level 2
- Scopus rating (2011): CiteScore 3.2 SJR 1.733 SNIP 2.957
- Web of Science (2011): Impact factor 2.784
- ISI indexed (2011): ISI indexed yes
- Web of Science (2011): Indexed yes
- BFI (2010): BFI-level 2
- Scopus rating (2010): SJR 1.737 SNIP 2.401
- Web of Science (2010): Impact factor 2.259
128 × 2 Gb/s WDM PON System with a Single TDM Time Lens Source using an AlGaAs-On-Insulator Waveguide

We demonstrate a WDM-PON transmitter based on optical Fourier transformation of a single-source TDM-PON. Using a single AlGaAs on-insulator waveguide, 128 WDM-PON signals at 2 Gb/s are generated and transmitted over a 100-km unamplified link.

General information
State: Published
Organisations: Department of Photonics Engineering, High-Speed Optical Communication, Centre of Excellence for Silicon Photonics for Optical Communications, Nanophotonic Devices, Diode Lasers and LED Systems
Contributors: Guan, P., Da Ros, F., Pu, M., Lillieholm, M., Zheng, Y., Semenova, E., Bony, P., Galli, M., Morioka, T., Yvind, K., Oxenløwe, L. K.
Number of pages: 2
Pages: 1-2
Publication date: 2018

Host publication information
Title of host publication: Proceedings of 2018 Conference on Lasers and Electro-Optics (CLEO)
Publisher: Optical Society of America
ISBN (Print): 9781943580422
Keywords: Wavelength division multiplexing, Time division multiplexing, Optical transmitters, Optical fibers, Optical fiber dispersion, Passive optical networks
DOIs: 10.1364/CLEO_SI.2018.SM2C.3

Bibliographical note
Annealing-free Si3N4 frequency combs for monolithic integration with Si photonics

Silicon-nitride-on-insulator (SiNOI) is an attractive platform for optical frequency comb generation in the telecommunication band because of the low two-photon absorption and free carrier induced nonlinear loss when compared with crystalline silicon. However, high-temperature annealing that has been used so far for demonstrating Si3N4-based frequency combs made co-integration with silicon-based optoelectronics elusive, thus reducing dramatically its effective complementary metal oxide semiconductor (CMOS) compatibility. We report here on the fabrication and testing of annealing-free SiNOI nonlinear photonic circuits. In particular, we have developed a process to fabricate low-loss, annealing-free, and crack-free Si3N4 740-nm-thick films for Kerr-based nonlinear photonics featuring a full process compatibility with front-end silicon photonics. Experimental evidence shows that micro-resonators using such annealing-free silicon nitride films are capable of generating a frequency comb spanning 1300–2100 nm via optical parametrical oscillation based on four-wave mixing. This work constitutes a decisive step toward time-stable power-efficient Kerr-based broadband sources featuring full process compatibility with Si photonic integrated circuits on CMOS lines.
Broadband Light Sources Based On Highly-Nonlinear AlGaAs-On-Insulator Waveguide Devices

We discuss broadband light generation based on Kerr nonlinearity in the highly-nonlinear AlGaAs-on-insulator waveguide platform. We review the recent demonstrations of utilization of such light sources in telecommunication systems.

General Information

State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices, Centre of Excellence for Silicon Photonics for Optical Communications, High-Speed Optical Communication
Contributors: Pu, M., Hu, H., Guan, P., Semenova, E., Oxenløwe, L. K., Yvind, K.
Number of pages: 2
Compact high-efficiency vortex beam emitter based on a silicon photonics micro-ring

Photonic integrated devices that emit vortex beam carrying orbital angular momentum are becoming key components for multiple applications. Here we propose and demonstrate a high-efficiency vortex beam emitter based on a silicon micro-ring resonator integrated with a metal mirror. Such a compact emitter is capable of generating vortex beams with a high efficiency and small divergence angle. Vector vortex beams of various topological charges are selectively generated by the emitter at different wavelengths with an emission efficiency of up to 37%. (C) 2018 Optical Society of America

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices, High-Speed Optical Communication, Centre of Excellence for Silicon Photonics for Optical Communications, Sun Yat-Sen University, Chinese Academy of Sciences
Pages: 1319-1322
Publication date: 2018
Peer-reviewed: Yes

Publication information
Journal: Optics Letters
Volume: 43
Issue number: 6
ISSN (Print): 0146-9592
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.89 SJR 1.79 SNIP 1.597
Web of Science (2017): Impact factor 3.589
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.54 SJR 1.769 SNIP 1.549
Web of Science (2016): Impact factor 3.416
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 3.53 SJR 2.013 SNIP 1.53
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 3.86 SJR 2.429 SNIP 1.997
Web of Science (2014): Impact factor 3.292
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 3.95 SJR 2.441 SNIP 2.058
Fano Resonances for Realizing Compact and Low Energy Consumption Photonic Switches

We present our recent experimental work involving nanocavities which enable efficient light-matter interaction in small optical mode volumes. To achieve this, we investigated photonic crystal membrane platforms for designing high-quality (Q) factor nanocavities and efficient planar waveguides. Particularly, we discuss waveguide-nanocavity coupled systems for realization of asymmetric Fano resonances which are characterized by having transmission maximum and minimum in close spectral separation (~1nm) suitable for optical switching applications.
Frequency comb generation in crack-free Si-photonics compatible Si3N4 microresonator chip

We present frequency comb generation in crack- and annealing-free Si3N4 microresonator chips fabricated using novel Si-photonics compatible processing.

Highly Nonlinear Gallium Nitride Waveguides

We demonstrate a high effective nonlinearity in high refractive-index-contrast gallium nitride waveguides by performing four-wave mixing characterization. The intrinsic material nonlinearity (n2) of gallium nitride is extracted at telecom wavelengths.
High Q AlGaAs-On-Sapphire Microresonators

We demonstrate an AlGaAs-on-sapphire (AlGaAsOS) microresonator with intrinsic quality factor (Q) as high as 460,000. We investigate the thermal property of this platform. The realization of the AlGaAsOS platform also opens new prospects for AlGaAs devices in nonlinear applications in the mid-infrared wavelength range.

Low temperature bonding of heterogeneous materials using Al2O3 as an intermediate layer

Direct wafer bonding is a key enabling technology for many current and emerging photonic devices. Most prior work on direct wafer bonding has, however, focused on the Si platform for fabrication of silicon-on-insulator (SOI) and micromechanical systems (MEMS). As a result, a universal bonding solution for heterogeneous material systems has not yet been developed. This has been a roadblock in the realization of novel devices which need the integration of new semiconductor platforms such as III-V on Si, Ge on Sapphire, LiNbO3 on GaAs etc. The large thermal expansion coefficient mismatch in the hetero-material systems limits the annealing to low temperatures to avoid stressed films. This work explores the use of Al2O3 as an intermediate layer for bonding heterogeneous materials. The key to achieve a stronger bond is to maximize the hydroxyl group density of the bonding interfaces. The use of Al2O3 helps achieve that, since it has a high hydroxyl group density (around 18 OH/nm2 at RT) which is approximately 4 times that of a Si surface. This work optimizes the bonding process using Al2O3 by studying the contribution of Al2O3 deposition parameters. An optimized process is presented and applied to bond GaAs on Sapphire and InP on SiO2/Si.
Low temperature bonding of heterogeneous materials using Al$_2$O$_3$ as an intermediate layer

Integration of heterogeneous materials is crucial for many nanophotonic devices. The integration is often achieved by bonding using polymer adhesives or metals. A much better and cleaner option is direct wafer bonding, but the high annealing temperatures required make it a much less attractive option. Direct wafer bonding relies on a high density of hydroxyl groups on the surfaces, which may be difficult to achieve depending on the materials. Thus, it is a challenge to design a universal wafer bonding process. However, using an intermediate layer between the bonding surfaces reduces the dependence on the bonding materials, and thus, the bonding mechanism essentially remains the same. The authors present a systematic study on the use of Al$_2$O$_3$ as an intermediate layer for bonding of heterogeneous materials. The ability to achieve high hydroxyl group density and well-controlled films makes atomic layer deposited Al$_2$O$_3$ an excellent choice for the intermediate layer. The authors have optimized the bonding process to achieve a high interface energy of 1.7 J/m$^2$ for a low temperature annealing of 300 °C. The authors also demonstrate wafer bonding of InP to SiO$_2$ on Si and GaAs to sapphire using the Al$_2$O$_3$ interlayer. Published by the AVS.

General information

State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices, Diode Lasers and LED Systems, Department of Micro- and Nanotechnology, Silicon Microtechnology, Centre of Excellence for Silicon Photonics for Optical Communications
Contributors: Sahoo, H. K., Ottaviano, L., Zheng, Y., Hansen, O., Yvind, K.
Number of pages: 6
Publication date: 2018
Peer-reviewed: Yes

Publication information

Volume: 36
Issue number: 1
Article number: 011202
ISSN (Print): 1071-1023
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 1.25 SJR 0.467 SNIP 0.631
Web of Science (2017): Impact factor 1.314
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.08 SJR 0.595 SNIP 0.691
Web of Science (2016): Impact factor 1.573
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 0.66 SJR 0.533 SNIP 0.641
Web of Science (2015): Impact factor 1.398
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 0.61 SJR 0.509 SNIP 0.601
Nano-engineered high-confinement AlGaAs waveguide devices for nonlinear photonics

The combination of nonlinear and integrated photonics enables applications in telecommunication, metrology, spectroscopy, and quantum information science. Pioneer works in silicon-on-insulator (SOI) has shown huge potentials of integrated nonlinear photonics. However, silicon suffers two-photon absorption (TPA) in the telecom wavelengths around 1550 nm, which hampers its practical applications. To get a superior nonlinear performance, an ideal integrated waveguide platform should combine a high material nonlinearity, low material absorption (linear and nonlinear), a strong
light confinement, and a mature fabrication technology. Aluminum gallium arsenide (AlGaAs) was identified as a promising candidate for nonlinear applications since 1994. It offers a large transparency window, a high refractive index (n approximate to 3.3), a nonlinear index (n2) on the order of 10(-17) m(2)W(-1), and the ability to engineer the material bandgap to mitigate TPA. In spite of the high intrinsic nonlinearity, conventional deep-etched AlGaAs waveguides exhibit low effective nonlinearity due to the vertical low-index contrast. To take full advantage of the high intrinsic linear and nonlinear index of AlGaAs material, we reconstructed the conventional AlGaAs waveguide into a high index contrast layout that has been realized in the AlGaAs-on-insulator (AlGaAsOI) platform. We have demonstrated low loss waveguides with an ultra-high nonlinear coefficient and high Q microresonators in such a platform. Owing to the high confinement waveguide layout and state-of-the-art nanolithography techniques, the dispersion properties of the AlGaAsOI waveguide can be tailored efficiently and accurately by altering the waveguide shape or dimension, which enables various applications in signal processing and generation, which will be reviewed in this paper.

General information
State: Published
Organisations: Centre of Excellence for Silicon Photonics for Optical Communications, Nanophotonic Devices, Department of Photonics Engineering, Diode Lasers and LED Systems, Fiber Optics, Devices and Non-linear Effects, High-Speed Optical Communication, Technical University of Denmark
Pages: 106721R-106721R-7
Publication date: 2018

Host publication information
Title of host publication: Proceedings of SPIE
Volume: 10672
Publisher: SPIE - International Society for Optical Engineering
Keywords: Integrated optics, Nonlinear optics, Nonlinear materials, Parametric processes, Optical signal processing, Optical communication, Frequency comb, Supercontinuum generation
Electronic versions:
106721R.pdf
DOIs:
10.1117/12.2307114
Source: Findit
Source-ID: 2437614425
Research output: Research - peer-review > Article in proceedings – Annual report year: 2018

Orbital angular momentum modes emission from a silicon photonic integrated device for km-scale data-carrying fiber transmission
We experimentally demonstrate orbital angular momentum (OAM) modes emission from a high emission efficiency OAM emitter for 20-Gbit/s quadrature phase-shift keying (QPSK) carrying data transmission in few-mode fiber (FMF). The device is capable of emitting vector optical vortices carrying well-defined OAM efficiently with the efficiency of the device >37%. Seven modes propagate through a 2-km two-mode and a 3.6-km three-mode FMF with measured optical signal-to-noise ratio (OSNR) penalties less than 4 dB at a bit-error rate (BER) of 2 x 10(-3). The demonstrations with favorable performance pave the way to incorporate silicon photonic integrated devices as transceivers in an OAM-enabled optical fiber communication link. (C) 2018 Optical Society of America under the terms of the OSA Open Access Publishing Agreement

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices, High-Speed Optical Communication, Centre of Excellence for Silicon Photonics for Optical Communications, Huazhong University of Science and Technology, Sun Yat-Sen University, Fiberhome Telecommunication Technologies Co. Ltd, Wuhan National Laboratory for Optoelectronics
Pages: 15471-15479
Publication date: 2018
Peer-reviewed: Yes

Publication information
Journal: Optics Express
Volume: 26
Issue number: 12
ISSN (Print): 1094-4087
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.74 SJR 1.519 SNIP 1.567
Web of Science (2017): Impact factor 3.356
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.48 SJR 1.532 SNIP 1.544
Web of Science (2016): Impact factor 3.307
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 3.78 SJR 1.91 SNIP 1.674
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 4.18 SJR 2.313 SNIP 2.124
Web of Science (2014): Impact factor 3.488
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 4.38 SJR 2.337 SNIP 2.196
Web of Science (2013): Impact factor 3.525
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 3.85 SJR 2.562 SNIP 2.108
Web of Science (2012): Impact factor 3.546
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 4.04 SJR 2.58 SNIP 2.572
Web of Science (2011): Impact factor 3.587
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.906 SNIP 2.428
Web of Science (2010): Impact factor 3.753
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 3.039 SNIP 2.679
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 3.204 SNIP 2.423
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 3.284 SNIP 2.11
Web of Science (2007): Indexed yes
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 3.313 SNIP 2.336
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 2.819 SNIP 2.472
Pulse carving using nanocavity-enhanced nonlinear effects in photonic crystal Fano structures
We experimentally demonstrate the use of a photonic crystal Fano resonance for carving-out short pulses from long-duration input pulses. This is achieved by exploiting an asymmetric Fano resonance combined with carrier-induced nonlinear effects in a photonic crystal membrane structure. The use of a nanocavity concentrates the input field to a very small volume leading to an efficient nonlinear resonance shift that carves a short pulse out of the input pulse. Here, we demonstrate shortening of ∼500 ps and ∼100 ps long pulses to ∼30 ps and ∼20 ps pulses, respectively. Furthermore, we demonstrate error-free low duty cycle return-to-zero signal generation at 2 Gbit/s with energy consumption down to ∼1 pJ/bit and power penalty of ∼2 dB. The device physics and limitations are analyzed using nonlinear coupled-mode theory.

General information
State: Published
Organisations: Department of Photonics Engineering, High-Speed Optical Communication, Centre of Excellence for Silicon Photonics for Optical Communications, Nanophotonic Devices
Pages: 955-958
Publication date: 2018
Peer-reviewed: Yes

Publication information
Journal: Optics Letters
Volume: 43
Issue number: 4
ISSN (Print): 0146-9592
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.89 SJR 1.79 SNIP 1.597
Web of Science (2017): Impact factor 3.589
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.54 SJR 1.769 SNIP 1.549
Web of Science (2016): Impact factor 3.416
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 3.53 SJR 2.013 SNIP 1.53
Reducing insulating substrate charging in electron beam lithography without using charge dissipation layer
We investigate charging effect in electron beam lithography for patterning resist on electrically insulating substrate. We find that the charging effect can be mitigated without using a charge dissipation layer with an optimized exposure writing order strategy. We successfully fabricate an AlGaAs-on-sapphire (AlGaAsOS) microresonator with intrinsic quality factor (Q) as ~100,000 with the optimized EBL process.

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices, Diode Lasers and LED Systems, Centre of Excellence for Silicon Photonics for Optical Communications
Contributors: Zheng, Y., Pu, M., Yvind, K.
Number of pages: 1
Publication date: 2018

Host publication information
Title of host publication: Proceedings of 44th International Conference on Micro and Nano Engineering
Publisher: IEEE
Keywords: Electron beam lithography, Charging effect, AlGaAs-on-insulator
Electronic versions:
Reducing_insulating_substrate_charging_in_electron_beam_lithography_without_using_charge_dissipation_layer.pdf
Source: PublicationPreSubmission
Source-ID: 163151961
Research output: Research - peer-review › Article in proceedings – Annual report year: 2018

Signal reshaping and noise suppression using photonic crystal Fano structures
We experimentally demonstrate the use of photonic crystal Fano resonances for reshaping optical data signals. We show that the combination of an asymmetric Fano resonance and carrier-induced nonlinear effects in a nanocavity can be used to realize a nonlinear power transfer function, which is a key functionality for optical signal regeneration, particularly for suppression of amplitude fluctuations of data signals. The experimental results are explained using simulations based on coupled-mode theory and also compared to the case of using conventional Lorentzian-shaped resonances. Using indium phosphide photonic crystal membrane structures, we demonstrate reshaping of 2 Gbit/s and 10 Gbit/s return-to-zero on-off keying (RZ-OOK) data signals at telecom wavelengths around 1550 nm. Eye diagrams of the reshaped signals show that amplitude noise fluctuations can be significantly suppressed. The reshaped signals are quantitatively analyzed using bit-error ratio (BER) measurements, which show up to 2 dB receiver sensitivity improvement at a BER of 10^-9 compared to a degraded input noisy signal. Due to efficient light-matter interaction in the high-quality factor and small mode-volume photonic crystal nanocavity, low energy consumption, down to 104 fJ/bit and 41 fJ/bit for 2 Gbit/s and 10 Gbit/s, respectively, has been achieved. Device perspectives and limitations are discussed.

General information
State: Published
Organisations: Department of Photonics Engineering, Quantum and Laser Photonics, High-Speed Optical Communication, Centre of Excellence for Silicon Photonics for Optical Communications, Nanophotonic Devices
Pages: 19596-19605
Publication date: 2018
Peer-reviewed: Yes

Publication information
Journal: Optics Express
Volume: 26
Issue number: 15
ISSN (Print): 1094-4087
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.74 SJR 1.519 SNIP 1.567
Web of Science (2017): Impact factor 3.356
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.48 SJR 1.532 SNIP 1.544
Web of Science (2016): Impact factor 3.307
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 3.78 SJR 1.91 SNIP 1.674
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 4.18 SJR 2.313 SNIP 2.124
Web of Science (2014): Impact factor 3.488
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 4.38 SJR 2.337 SNIP 2.196
Web of Science (2013): Impact factor 3.525
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 3.85 SJR 2.562 SNIP 2.108
Web of Science (2012): Impact factor 3.546
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 4.04 SJR 2.58 SNIP 2.572
Web of Science (2011): Impact factor 3.587
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.906 SNIP 2.428
Web of Science (2010): Impact factor 3.753
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 3.039 SNIP 2.679
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 3.204 SNIP 2.423
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 3.284 SNIP 2.11
Web of Science (2007): Indexed yes
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 3.313 SNIP 2.336
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 2.819 SNIP 2.472
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 2.669 SNIP 2.217
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 1.745 SNIP 1.748
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 1.496 SNIP 1.42
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 0.98 SNIP 0.761
Signal-to-Idler Conversion Penalty in AlGaAs-on-Insulator Wavelength Converter

A wavelength converter based on AlGaAsOI waveguide is characterized by varying the input signal quality. Signal-to-idler conversion penalty is measured in terms of effective received SNR, and trade-offs between penalty and converted signal quality are outlined.

General information
State: Published
Organisations: Department of Photonics Engineering, High-Speed Optical Communication, Centre of Excellence for Silicon Photonics for Optical Communications, Nanophotonic Devices, Coding and Visual Communication
Contributors: Kaminski, P. M., Da Ros, F., Porto da Silva, E., Pu, M., Yankov, M. P., Semenova, E., Yvind, K., Oxenløwe, L. K., Forchhammer, S., Galili, M.
Number of pages: 2
Publication date: 2018

Host publication information
Title of host publication: CLEO: Science and Innovations 2018
Publisher: Optical Society of America
Article number: Paper STu4C.6
Electronic versions:
PKAM_CLEO2018_submitted.pdf
DOIs:
10.1364/CLEO_SI.2018.STu4C.6

Bibliographical note
From the session: Nonlinearity Compensation (STu4C)
Research output: Research - peer-review » Journal article – Annual report year: 2018

Single-source chip-based frequency comb enabling extreme parallel data transmission

The Internet today transmits hundreds of terabits per second, consumes 9% of all electricity worldwide and grows by 20-30% per year(1,2). To support capacity demand, massively parallel communication links are installed, not scaling favourably concerning energy consumption. A single frequency comb source may substitute many parallel lasers and improve system energy-efficiency(3,4). We present a frequency comb realized by a non-resonant aluminium-gallium-arsenide-on-insulator (AlGaAsOI) nanowaveguide with 66% pump-to-comb conversion efficiency, which is significantly higher than state-of-the-art resonant comb sources. This enables unprecedented high data-rate transmission for chip-based sources, demonstrated using a single-mode 30-core fibre. We show that our frequency comb can carry 661 Tbit s(-1) of data, equivalent to more than the total Internet traffic today. The comb is obtained by seeding the AlGaAsOI chip with 10-GHz picosecond pulses at a low pump power (85 mW), and this scheme is robust to temperature changes, is energy efficient and facilitates future integration with on-chip lasers or amplifiers(5,6).

General information
State: Published
Organisations: Department of Photonics Engineering, High-Speed Optical Communication, Centre of Excellence for Silicon Photonics for Optical Communications, Nanophotonic Devices, Fujikura Ltd., Technical University of Denmark
Contributors: Hu, H., Da Ros, F., Pu, M., Ye, F., Ingerslev, K., Porto da Silva, E., Nooruzzaman, M., Amma, Y., Sasaki, Y., Mizuno, T., Miyamoto, Y., Ottaviano, L., Semenova, E., Guan, P., Zibar, D., Galili, M., Yvind, K., Moroika, T., Oxenløwe, L. K.
Pages: 469-74
Publication date: 2018
SiNOI and AlGaAs-on-SOI nonlinear circuits for continuum generation in Si photonics

In this communication, we report on the design, fabrication, and testing of Silicon Nitride on Insulator (SiNOI) and Aluminum-Gallium-Arsenide (AlGaAs) on silicon-on-insulator (SOI) nonlinear photonic circuits for continuum generation in Silicon (Si) photonics. As recently demonstrated, the generation of frequency continua and supercontinua can be used to overcome the intrinsic limitations of nowadays silicon photonics notably concerning the heterogeneous integration of III-V on SOI lasers for datacom and telecom applications. By using the Kerr nonlinearity of monolithic silicon nitride and heterointegrated GaAs-based alloys on SOI, the generation of tens or even hundreds of new optical frequencies can be obtained in dispersion tailored waveguides, thus providing an all-optical alternative to the heterointegration of hundreds of standalone III-V on Si lasers. In our work, we present paths to energy-efficient continua generation on silicon photonics circuits. Notably, we demonstrate spectral broadening covering the full C-band via Kerrbased self-phase modulation in SiNOI nanowires featuring full process compatibility with Si photonic devices. Moreover, AlGaAs waveguides are heterointegrated on SOI in order to dramatically reduce (x1/10) thresholds in optical parametric oscillation and in the power required for supercontinuum generation under pulsed pumping. The manufacturing techniques allowing the monolithic co-integration of nonlinear functionalities on existing CMOS-compatible Si photonics for both active and passive components will be shown. Experimental evidence based on self-phase modulation show SiNOI and AlGaAs nanowires capable of generating wide-spanning frequency continua in the C-Band. This will pave the way for low-Threshold power-efficient Kerr-based comb-and continuum-sources featuring compatibility with Si photonic integrated circuits (Si-PICs).

Ultra-Efficient and Broadband Nonlinear AlGaAs-on-Insulator Chip for Low-Power Optical Signal Processing

Four-wave mixing (FWM) is a versatile optical nonlinear parametric process that enables a plethora of signal processing functionalities in optical communication. Realization of efficient and broadband all-optical signal processing with ultra-low energy consumption has been elusive for decades. Although tremendous efforts have been put into developing various material platforms, it has remained a challenge to obtain both high efficiency and broadband operation. Here, an aluminum gallium arsenide nonlinear chip with high FWM conversion efficiency per length per pump power and an ultra-broad bandwidth is presented. Combining an ultra-high material nonlinearity and strong effective nonlinear enhancement from a high-index-contrast waveguide layout, an ultra-high conversion efficiency of 4 dB is obtained in a 3-mm-long nanowaveguide. Taking advantage of high-order dispersion, a scheme is presented to realize an ultra-broad continuous conversion bandwidth covering 1280–2020 nm. A microresonator is also utilized to demonstrate a conversion efficiency enhancement gain of more than 50 dB with respect to a waveguide device, which significantly reduces the power consumption. Moreover, wavelength conversion of an optical serial data signal is performed at a bit rate beyond terabit-per-second, showing the capabilities of this III-V semiconductor material for broadband optical signal processing.
Wavelength tunable MEMS VCSELs for OCT imaging

MEMS VCSELs are one of the most promising swept source (SS) lasers for optical coherence tomography (OCT) and one of the best candidates for future integration with endoscopes, surgical probes and achieving an integrated OCT system. However, the current MEMS-based SS are processed on the III-V wafers, which are small, expensive and challenging to work with. Furthermore, the actuating part, i.e., the MEMS, is on the top of the structure which causes a strong dependence on packaging to decrease its sensitivity to the operating environment. This work addresses these design drawbacks and proposes a novel design framework. The proposed device uses a high contrast grating mirror on a Si MEMS stage as the bottom mirror, all of which is defined in an SOI wafer. The SOI wafer is then bonded to an InP III-V wafer with the desired active layers, thereby sealing the MEMS. Finally, the top mirror, a dielectric DBR (7 pairs of TiO2 - SiO2), is deposited on top. The new device is based on a silicon substrate with MEMS defined on a silicon membrane in an enclosed cavity. Thus the device is much more robust than the existing MEMS VCSELs. This design also enables either a two-way actuation on the MEMS or a smaller optical cavity (pull-away design), i.e., wider FSR (Free Spectral Range) to increase the wavelength sweep. Fabrication of the proposed device is outlined and the results of device characterization are reported.

10 GHz frequency comb spectral broadening in AlGaAs-on-Insulator nano-waveguide with ultra-low pump power

We experimentally demonstrated 10 GHz frequency comb spectral broadening with a 30-dB bandwidth of 238 nm in an 11-mm long AlGaAsOI nano-waveguide. The 10-GHz 230-fs pump pulse has an average power of only 12 mW.
An ultra-efficient nonlinear planar integrated platform for optical signal processing and generation

This paper will discuss the recently developed integrated platform: AlGaAs-on-insulator and its broad range of nonlinear applications. Recent demonstrations of broadband optical signal processing and efficient frequency comb generations in this platform will be reviewed.

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices, High-Speed Optical Communication, Fiber Optics, Devices and Non-linear Effects, Diode Lasers and LED Systems
Publication date: 2017

Characterization and optimization of a high-efficiency AlGaAs-On-Insulator-based wavelength converter for 64- and 256-QAM signals

In this paper, we demonstrate wavelength conversion of advanced modulation formats such as 10-GBd 64-QAM and 256-QAM with high conversion efficiency over a 29-nm spectral window by using four-wave mixing in an AlGaAs-On-Insulator (AlGaAsOI) nano-waveguide. A thorough characterization of the wavelength converter is reported, including the optimization of the AlGaAsOI nano-waveguide in terms of conversion efficiency and associated bandwidth and the analysis of the impact of the converter pump quality and power as well as the signal input power. The optimized converter enables generating idlers with optical signal-to-noise ratio (OSNR) above 30 dB over a 29-nm bandwidth leading to error-free conversion of 64-QAM and 256-QAM with OSNR penalty below 1.0 dB and 2.0 dB respectively. The generated idlers exhibit an OSNR margin to the chosen forward error correction thresholds of >3 dB and >7 dB for 64-QAM and 256-QAM, respectively, that can be used for transmission after conversion.

General information
State: Published
Organisations: Department of Photonics Engineering, High-Speed Optical Communication, Centre of Excellence for Silicon Photonics for Optical Communications, Coding and Visual Communication, Nanophotonic Devices
Number of pages: 8
Pages: 3750-3757
Publication date: 2017
Peer-reviewed: Yes
Scopus rating (2003): SJR 2.703 SNIP 2.876
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 2.751 SNIP 2.588
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 2.999 SNIP 2.112
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 2.379 SNIP 1.821
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 2.342 SNIP 1.659

Original language: English
Keywords: Four-wave mixing, Integrated waveguides, Quadrature amplitude modulation, Coherent communications

Electronic versions:
DaRos_JLT2017_prePrint.pdf

DOIs:
10.1109/JLT.2017.2722013

Bibliographical note
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Source: PublicationPreSubmission
Source-ID: 133665129
Research output: Research - peer-review › Journal article – Annual report year: 2017

Demonstration of a self-pulsing photonic crystal Fano laser
The semiconductor lasers in use today rely on various types of cavity, making use of Fresnel reflection at a cleaved facet⁴, total internal reflection between two different median, Bragg reflection from a periodic stack of layers(3-8), mode coupling in a high contrast grating(9,10) or random scattering in a disordered medium⁵. Here, we demonstrate an ultrasmall laser with a mirror, which is based on Fano interference between a continuum of waveguide modes and the discrete resonance of a nanocavity. The rich physics of Fano resonances(12) has recently been explored in a number of different photonic and plasmonic systems(13,14). The Fano resonance leads to unique laser characteristics. In particular, because the Fano mirror is very narrowband compared to conventional laser mirrors, the laser is single mode and can be modulated via the mirror. We show, experimentally and theoretically, that nonlinearities in the mirror may even promote the generation of a self-sustained train of pulses at gigahertz frequencies, an effect that has previously been observed only in macroscopic lasers(15-18). Such a source is of interest for a number of applications within integrated photonics.

General information
State: Published
Organisations: Department of Photonics Engineering, Quantum and Laser Photonics, Nanophotonic Devices
Contributors: Yu, Y., Xue, W., Semenova, E., Yvind, K., Mørk, J.
Pages: 81-84
Publication date: 2017
Peer-reviewed: Yes

Publication information
Journal: Nature Photonics
Volume: 11
Issue number: 2
ISSN (Print): 1749-4885

Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Web of Science (2017): Impact factor 32.521
Web of Science (2017): Indexed yes
Scopus rating (2016): CiteScore 21.32 SJR 15.689 SNIP 9.187
Experimental demonstration of a Fano laser based on photonic crystals

Conventional semiconductor laser mirrors are based on Fresnel reflection [1], Bragg reflection [2, 3] or total internal reflection [4]. Here we demonstrate a new laser concept using photonic crystals (PhC), with a mirror based on Fano interference between a waveguide continuum and a discrete resonance of a nanocavity [5]. We show that the very narrowband feature of the Fano resonance [6] can lead to single mode lasing. In addition, when combined with optical nonlinearity, the highly dispersive feature of the Fano resonance can promote self-pulsations at gigahertz frequencies [7], which was previously observed only in macroscopic lasers [8].
Fabrication and experimental demonstration of photonic crystal laser with buried heterostructure

Development of ultra-small and efficient laser sources for photonic integrated circuits is one of the main cornerstones in achieving the requirements imposed for on-chip optical interconnects [1]. The InP photonic crystal (PhC) platform with selectively embedded gain medium [2] is a promising way of separating active light amplification regions from passive regions for light propagation without induced absorption losses and surface recombination. The main focus of this work is the fabrication and experimental demonstration of a buried heterostructure (BH) photonic crystal laser bonded to a silicon wafer, illustrating the effective single-platform active-passive material integration method.

High Q gallium nitride microring resonators

Summary form only given. Gallium nitride (GaN) is a promising material for nonlinear microresonators. It has large intrinsic $\chi(2)$ and $\chi(3)$, excellent thermal properties and a relatively large bandgap [1] and can be used for example for parametric conversion and frequency doubling [2]. Furthermore it is quite resilient and can withstand high temperatures and power. In this paper, we demonstrate GaN microring resonators with a quality factor (Q) larger than 105, which, to the best of our knowledge, is the highest demonstrated Q for microring resonators in a pure GaN platform [3].
Lasers, switches and non-reciprocal elements based on photonic crystal Fano resonances
We discuss the realization of active photonic devices exploiting Fano resonances in photonic crystal membranes.

General information
State: Published
Organisations: Department of Photonics Engineering, Quantum and Laser Photonics, Nanophotonic Devices, Technical University of Denmark
Number of pages: 2
Pages: 1-2
Publication date: 2017

Host publication information
Title of host publication: Proceedings of the 17th International Conference on Numerical Simulation of Optoelectronic Devices
Publisher: IEEE
ISBN (Print): 9781509053230
DOIs:
10.1109/NUSOD.2017.8009961
Source: FindIt
Source-ID: 2373491818
Research output: Research - peer-review › Article in proceedings – Annual report year: 2017

Low threshold frequency comb generation in AlGaAs-on-insulator microresonator in the normal dispersion regime
We present milli-Watt threshold frequency comb generation in AlGaAs-on-insulator integrated microresonators exhibiting normal GVD by employing the effects of mode interaction.

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
Contributors: Kamel, A. N., Pu, M., Yvind, K.
Number of pages: 2
Publication date: 2017

Host publication information
Title of host publication: 2017 Conference on Lasers and Electro-Optics
Publisher: Optical Society of America (OSA)
ISBN (Print): 9781943580279
Keywords: Microcavities, Dispersion, Optical frequency conversion, Optical fiber amplifiers, Wavelength measurement, Optical fiber devices
Electronic versions:
CLEO2017_Ayman_final.pdf
DOIs:
10.1364/CLEO_QELS.2017.FTu1D.3

Bibliographical note
From the session: On-chip Comb Generation I (FTu1D)
Source: FindIt
Source-ID: 2392559549
Research output: Research - peer-review › Article in proceedings – Annual report year: 2017
On the high characteristic temperature of an InAs/GaAs/InGaAsP QD laser with an emission wavelength of ~1.5 μm on an InP substrate

We report on a study of lasers with an emission wavelength of about 1.5 μm and high temperature stability, synthesized on an InP (001) substrate. Self-organized InAs quantum dots capped with a thin GaAs layer are used as the active region of the laser. A quaternary InGaAsP solid solution with a band-gap width of 1.15 eV serves as the waveguide/matrix layer. A high characteristic temperature of the threshold current, $T_0 = 205$ K, is reached in the temperature range 20–50°C in ridge-waveguide laser diodes. A correlation between the values of $T_0$ and the band-gap width of the waveguide layers is found.

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices, St. Petersburg National Research University Academic of the Russian Academy of Sciences
Contributors: Zubov, F., Semenova, E., Kulkova, I., Yvind, K., Kryzhanovskaya, N., Maximov, M., Zhukov, A.
Pages: 1332-1336
Publication date: 2017
Peer-reviewed: Yes

Publication information
Journal: Semiconductors
Volume: 51
Issue number: 10
ISSN (Print): 1063-7826
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 0.68 SJR 0.362 SNIP 0.766
Web of Science (2017): Impact factor 0.672
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.69 SJR 0.37 SNIP 0.803
Web of Science (2016): Impact factor 0.602
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 0.83 SJR 0.455 SNIP 0.981
Web of Science (2015): Impact factor 0.701
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 0.74 SJR 0.482 SNIP 0.899
Web of Science (2014): Impact factor 0.739
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 0.67 SJR 0.429 SNIP 0.771
Web of Science (2013): Impact factor 0.705
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 0.59 SJR 0.447 SNIP 0.78
Web of Science (2012): Impact factor 0.6
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 0.43 SJR 0.323 SNIP 0.546
Web of Science (2011): Impact factor 0.627
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.257 SNIP 0.284
Web of Science (2010): Impact factor 0.605
Optical Time Domain Demultiplexing using Fano Resonance in InP Photonic Crystals

Parity control of Fano resonances and its application for signal regeneration and pulse carving

Parity control of Fano resonances in a photonic crystal waveguide coupled to a nanocavity is implemented by controlling the position of a partially transmitting element (PTE) in the waveguide. We experimentally demonstrate regeneration and pulse carving of optical signals by exploiting nonlinearities in the nanocavity in combination with the asymmetrical Fano shape.

Parity control of Fano resonances and its application for signal regeneration and pulse carving
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Photonic crystal Fano lasers and Fano switches
We show that Fano resonances can be realized in photonic crystal membrane structures by coupling line-defect waveguides and point-defect nanocavities. The Fano resonance can be exploited to realize optical switches with very small switching energy, as well as Fano lasers, that can generate short optical pulses.

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices
Pages: 88-89
Publication date: 2017

Host publication information
Title of host publication: Proceedings of the 22nd Microoptics Conference (MOC2017)
Publisher: IEEE
Article number: E-1 (Invited)
ISBN (Print): 9784863486096
DOIs: 10.23919/MOC.2017.8244505
Research output: Research - peer-review ; Article in proceedings – Annual report year: 2017

Photonic crystal Fano resonances for realizing optical switches, lasers and non-reciprocal elements
We present our work on photonic crystal membrane devices exploiting Fano resonance between a line-defect waveguide and a side coupled nanocavity. Experimental demonstration of fast and compact all-optical switches for wavelength-conversion is reported. It is shown how the use of an asymmetric structure in combination with cavity-enhanced nonlinearity can be used to realize non-reciprocal transmission at ultra-low power and with large bandwidth. A novel type of laser structure, denoted a Fano laser, is discussed in which one of the mirrors is based on a Fano resonance. Finally, the design, fabrication and characterization of grating couplers for efficient light coupling in and out of the indium phosphide photonic platform is discussed.

General information
State: Published
Organisations: Department of Photonics Engineering, Quantum and Laser Photonics, High-Speed Optical Communication, Nanophotonic Devices
Number of pages: 7
Publication date: 2017

Host publication information
Title of host publication: Proceedings of SPIE
Volume: 10345
Publisher: SPIE - International Society for Optical Engineering
Article number: 103451V
Keywords: All-optical switches, Fano laser, Grating coupler, Wavelength-conversion, Non-reciprocal transmission, Photonic crystal membrane
Electronic versions: spie_proceeding_Dagmawi_final.pdf
DOIs: 10.1117/12.2273801
Source: PublicationPreSubmission
Source-ID: 134869099
Research output: Research - peer-review ; Article in proceedings – Annual report year: 2017

Specific features of waveguide recombination in laser structures with asymmetric barrier layers
The spatial distribution of the intensity of the emission caused by recombination appearing at a high injection level (up to 30 kA/cm2) in the waveguide layer of a GaAs/AlGaAs laser structure with GaInP and AlGaNAs asymmetric barrier layers is studied by means of near-field scanning optical microscopy. It is found that the waveguide luminescence in such a laser, which is on the whole less intense as compared to that observed in a similar laser without asymmetric barriers, is non-uniformly distributed in the waveguide, so that the distribution maximum is shifted closer to the p-type cladding layer. This can be attributed to the ability of the GaInP barrier adjoining the quantum well on the side of the n-type cladding layer to suppress the hole transport.
Supercontinuum comb sources for broadband communications based on AlGaAs-on-insulator

We experimentally demonstrated 10 GHz frequency comb spectral broadening in an AlGaAsOI nano-waveguide with the peak power of only several watts. The spectral broadened 10 GHz frequency comb has high optical signal to noise ratio (OSNR) at the output of the nano-waveguide. As far as we know, it is the first photonic chip based frequency comb, relying on spectral broadening of a 10 GHz mode-locked laser comb in an AlGaAsOI nano-waveguide, with a sufficient comb output power to support several hundred Tbit/s optical data.

General information

State: Published
Organisations: Department of Photonics Engineering, High-Speed Optical Communication, Centre of Excellence for Silicon Photonics for Optical Communications, Nanophotonic Devices
Contributors: Hu, H., Pu, M., Da Ros, F., Galili, M., Yvind, K., Morioka, T., Oxenløwe, L. K.
Number of pages: 4
Publication date: 2017

Host publication information

Title of host publication: Proceedings of SPIE
Volume: 10088
Publisher: SPIE - International Society for Optical Engineering
Article number: 100880C

Keywords: Nanophotonic devices and technology, Laser beam modulation, pulsing and switching; mode locking and tuning, Optical harmonic generation, frequency conversion, parametric oscillation and amplification, Ultrafast optical techniques, Integrated optics

Electronic versions:
100880C_1_.pdf
DOIs:
10.1117/12.2256032

Bibliographical note

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Source: FindIt
Source-ID: 2370697047

Research output: Research - peer-review › Article in proceedings – Annual report year: 2017

Towards actively stabilized micro ring resonator based frequency combs

We present a simple and versatile scheme for active locking of a micro ring resonance to a highly stable fibre laser allowing continuous resonance tuning and locking on a time scale of 10 microseconds.
Towards Polarization-Independent Four-Wave Mixing in Dispersion Engineered AlGaAs-on-Insulator Nano-Waveguide

We demonstrate a polarization-independent continuous wave four-wave mixing conversion bandwidth of 70 nm (1530-1600 nm) in a dispersion engineered high-index contrast AlGaAs-on-insulator nano-waveguide. We obtain constant conversion efficiency over 175 nm for the TE mode.

Towards Ultra-High Q Microresonators in High-Index Contrast AlGaAs-On-Insulator

We demonstrate an AlGaAs-on-insulator microresonator with intrinsic Q as high as 690,000. We optimized the fabrication and investigated the impact of waveguide dimension on the Q in such a high-index contrast platform.
Ultra-broadband optical signal processing using AlGaAs-OI devices
Aluminum Gallium Arsenide on insulator (AlGaAs-OI) has recently been developed into a very attractive platform for optical signal processing. This paper reviews key results of broadband optical signal processing using this platform.

General information
State: Published
Organisations: Department of Photonics Engineering, High-Speed Optical Communication, Centre of Excellence for Silicon Photonics for Optical Communications, Nanophotonic Devices
Contributors: Galili, M., Da Ros, F., Hu, H., Pu, M., Yvind, K., Oxenløwe, L. K.
Number of pages: 3
Publication date: 2017

Host publication information
Title of host publication: Optical Fiber Communication Conference 2017
Volume: 2017
Publisher: Optical Society of America (OSA)
Article number: Th1F.5
ISBN (Print): 978-1-943580-23-1
(Optics Infobase Conference Papers).
Electronic versions:
Broadband_processing_in_AlGaAs_OFC_2017_v4.pdf
DOIs:
10.1364/OFC.2017.Th1F.5

Bibliographical note
From the session: Applications of Parametric Nonlinear Processors (Th1F)
Source: FindIt
Source-ID: 2371057620
Research output: Research - peer-review › Article in proceedings – Annual report year: 2017
Temperature characteristics of InAs/InGaAsP quantum dot (QD) lasers synthesized on InP (001) substrate are presented. The lasers demonstrate high temperature stability: a threshold current characteristic temperature as high as 205 K in the temperature range between 20 to 50°C was measured. Lasing wavelength of 1.5 μm was achieved by covering QDs with 1.7 monolayers of GaAs.
Keywords: Lasing action in semiconductors, Design of specific laser systems, Semiconductor lasers, gallium arsenide, III-V semiconductors, indium compounds, monolayers, quantum dot lasers, semiconductor quantum dots, InAs-InGaAsP-InP quantum dot laser, temperature stability, InP (001) substrate, threshold current, lasing wavelength, GaAs monolayers, temperature 205 K, temperature 20 degC to 50 degC, wavelength 1.5 mum, InAs-InGaAs-InP
All-Optical Switching Improvement Using Photonic-Crystal Fano Structures

We investigate the intensity and phase response of optical switches based on a photonic crystal waveguide coupled to a nanocavity. In particular, we compare the performances of switches with traditional Lorentzian transmission spectrum to switches displaying an asymmetric Fano shape, as obtained by incorporating a partially transmitting element in the waveguide. Compared to traditional Lorentzian structures, the Fano structure shows improved switching contrast and speed without adding any extra phase modulation, corresponding to a much lower chirp parameter. Using a simple and ultracompact InP photonic-crystal Fano structure with broken mirror symmetry, we experimentally demonstrate 20-Gb/s all-optical switching with low-energy consumption.
An Ultra-Efficient Nonlinear Platform: AlGaAs-On-Insulator

The combination of nonlinear and integrated photonics enables applications including optical signal processing, multi-wavelength lasers, metrology, spectroscopy, and quantum information science. Silicon-on-insulator (SOI) has emerged as a promising platform [1, 2] due to its high material nonlinearity and its compatibility with the CMOS industry. However, silicon suffers two-photon absorption (TPA) in the telecommunication wavelength band around 1.55 µm, which hampers its applications. Different platforms have been proposed to avoid TPA in the telecom wavelength range such as Si3N4 and Hydex [3]. Though tremendous technological work in those platforms have greatly improved device performances, the relatively low intrinsic material nonlinearities of those materials limit device performances concerning efficiency. Therefore, an integrated nonlinear platform that combines a high material nonlinearity, a high-index contrast as SOI, and low linear and nonlinear losses is highly desired. Aluminium gallium arsenide (AlGaAs) was early identified as a promising candidate and even nominated as “the silicon of nonlinear optical material” [4] when operated just below half its bandgap energy. It offers a nonlinear index (n2) on the order of 10−17 W/m² and a high refractive index (n ≈ 3.3), a large transparency window (from near- to mid-infrared), and the ability to engineer the material bandgap to mitigate TPA [5]. In this presentation, we introduce AlGaAs-on-insulator (AlGaAsOI) platform which combines both strong nonlinear light-matter interaction induced by high-index contrast layout and the potential to fabricate complex designs similar to what is done in silicon-on-insulator photonics. We demonstrate low loss (~ 1.4 dB/cm) nanowaveguides with an ultra-high nonlinear coefficient (~660 W−1 m−1) and microring resonators with quality factors on the order of 105 [6]. The large effective nonlinearity of such platform enables efficient nonlinear processes such as high-speed optical signal processing [7], supercontinuum generation, and Kerr frequency comb generation [8]. Moreover, the required operation power for signal generation processes such as optical parametric oscillation in the AlGaAsOI platform is well within the range of standard on-chip light sources. In line with the fast-growing hybrid integration trend to combine different materials in multiple levels on a single CMOS compatible chip, the AlGaAsOI platform is very promising for realizing a compact fully-integrated multi-wavelength light source for high bandwidth optical interconnects.

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices, Centre of Excellence for Silicon Photonics for Optical Communications, High-Speed Optical Communication
Contributors: Pu, M., Ottaviano, L., Semenova, E., Hu, H., Oxenløwe, L. K., Yvind, K.
Number of pages: 1
Publication date: 2016
Peer-reviewed: Yes
Event: Abstract from Progress In Electromagnetics Research Symposium 2016, Shanghai, China.
Electronic versions:
2016_08_PIERS_An_Ultra_Efficient_Nonlinear_Platform_AlgAsOI.pdf
DOIs:
10.1109/PIERS.2016.7735233
Source: PublicationPreSubmission
Broadband and Efficient Dual-Pump Four-Wave Mixing in AlGaAs-On-Insulator Nano-Waveguide

We characterize dual-pump four-wave-mixing in AlGaAs-on-insulator nano-waveguides and demonstrate an output conversion efficiency as high as −8.5 dB at 155-mW pump power. The idler optical signal-to-noise ratio is above 25 dB over a 26-nm bandwidth.

General information
State: Published
Organisations: Department of Photonics Engineering, High-Speed Optical Communication, Centre of Excellence for Silicon Photonics for Optical Communications, Nanophotonic Devices
Contributors: Da Ros, F., Pu, M., Ottaviano, L., Hu, H., Semenova, E., Galili, M., Yvind, K., Oxenløwe, L. K.
Number of pages: 2
Publication date: 2016

Host publication information
Title of host publication: CLEO: Science and Innovations 2016
Place of publication: San Jose, California United States
Publisher: Optical Society of America OSA
Article number: SM1E.3
DOIs: 10.1364/CLEO_SI.2016.SM1E.3
Source-ID: 124337238
Research output: Research - peer-review » Conference abstract in proceedings – Annual report year: 2016

Characterization of a Wavelength Converter for 256-QAM Signals Based on an AlGaAs-On-Insulator Nano-waveguide

High efficiency and broadband wavelength conversion in a 9-mm AlGaAs-On-Insulator waveguide is shown to provide high-quality (OSNR > 30 dB) idler generation over a 28-nm bandwidth enabling error-free conversion of 10-GBd 256-QAM with OSNR penalty below 2.5 dB.

General information
State: Published
Organisations: Department of Photonics Engineering, High-Speed Optical Communication, Coding and Visual Communication, Nanophotonic Devices
Number of pages: 3
Efficient frequency comb generation in AlGaAs-on-insulator
The combination of nonlinear and integrated photonics enables Kerr frequency comb generation in stable chip-based microresonators. Such a comb system will revolutionize applications, including multi-wavelength lasers, metrology, and spectroscopy. Aluminum gallium arsenide (AlGaAs) exhibits very high material nonlinearity and low nonlinear loss. However, difficulties in device processing and low device effective nonlinearity made Kerr frequency comb generation elusive. Here, we demonstrate AlGaAs-on-insulator as a nonlinear platform at telecom wavelengths with an ultra-high device nonlinearity. We show high-quality-factor (Q > 105) micro-resonators where optical parametric oscillations are achieved with milliwatt-level pump threshold powers, which paves the way for on-chip pumped comb generation.

Hybrid III-V/SOI resonant cavity enhanced photodetector
A hybrid III–V/SOI resonant-cavity-enhanced photodetector (RCE-PD) structure comprising a high-contrast grating (HCG) reflector, a hybrid grating (HG) reflector, and an air cavity between them, has been proposed and investigated. In the proposed structure, a light absorbing material is integrated as part of the HG reflector, enabling a very compact vertical cavity. Numerical investigations show that a quantum efficiency close to 100 % and a detection linewidth of about 1 nm can be achieved, which are desirable for wavelength division multiplexing applications. Based on these results, a hybrid
RCE-PD sample has been fabricated by heterogeneously integrating an InP-based material onto a silicon-on-insulator wafer and has been characterized, which shows a clear enhancement in photo-current at the designed wavelength. This indicates that the HG reflector provides a field enhancement sufficient for RCE-PD operation. In addition, a capability of feasibly selecting the detection wavelength during fabrication as well as a possibility of realizing silicon-integrated bidirectional transceivers are discussed.

**General information**

State: Published
Organisations: Department of Photonics Engineering, Quantum and Laser Photonics, Metro-Access and Short Range Systems, Nanophotonic Devices, Centre of Excellence for Silicon Photonics for Optical Communications
Contributors: Larkin, A., Taghizadeh, A., Park, G. C., Yvind, K., Chung, I.
Pages: 16512-16519
Publication date: 2016
Peer-reviewed: Yes

**Publication information**

Journal: Optics Express
Volume: 24
Issue number: 15
ISSN (Print): 1094-4087
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.74 SJR 1.519 SNIP 1.567
Web of Science (2017): Impact factor 3.356
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.48 SJR 1.532 SNIP 1.544
Web of Science (2016): Impact factor 3.307
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 3.78 SJR 1.91 SNIP 1.674
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 4.18 SJR 2.313 SNIP 2.124
Web of Science (2014): Impact factor 3.488
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 4.38 SJR 2.337 SNIP 2.196
Web of Science (2013): Impact factor 3.525
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 3.85 SJR 2.562 SNIP 2.108
Web of Science (2012): Impact factor 3.546
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 4.04 SJR 2.58 SNIP 2.572
Web of Science (2011): Impact factor 3.587
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Hybrid III-V/SOI Resonant Cavity Photodetector

A hybrid III-V/SOI resonant cavity photo detector has been demonstrated, which comprises an InP grating reflector and a Si grating reflector. It can selectively detect an incident light with 1.54-µm wavelength and TM polarization.

General information
State: Published
Organisations: Department of Photonics Engineering, Quantum and Laser Photonics, Nanophotonic Devices, Centre of Excellence for Silicon Photonics for Optical Communications
Contributors: Learkthanakhachon, S., Taghizadeh, A., Park, G. C., Yvind, K., Chung, I.
Number of pages: 2
Pages: 134-135
Publication date: 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.

General information

State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices, High-Speed Optical Communication, Centre of Excellence for Silicon Photonics for Optical Communications, Diode Lasers and LED Systems, Huazhong University of Science and Technology, Chalmers University of Technology, FOTON Laboratory
Pages: 362-376
Publication date: 2016
Peer-reviewed: Yes

Publication information

Journal: Frontiers of Optoelectronics
Volume: 9
Issue number: 3
ISSN (Print): 2095-2759
Ratings:
Web of Science (2019): Indexed yes
Web of Science (2018): Indexed yes
Scopus rating (2017): CiteScore 0.85 SJR 0.365 SNIP 0.457
Scopus rating (2016): CiteScore 0.88 SJR 0.316 SNIP 0.678
Scopus rating (2015): CiteScore 0.6 SJR 0.298 SNIP 0.387
Scopus rating (2014): CiteScore 0.68 SJR 0.286 SNIP 0.562
Scopus rating (2013): CiteScore 0.55 SJR 0.304 SNIP 0.44
ISI indexed (2013): ISI indexed no
Scopus rating (2012): SJR 0.22 SNIP 0.344
ISI indexed (2012): ISI indexed no
Scopus rating (2011): SJR 0.218 SNIP 0.372
ISI indexed (2011): ISI indexed no
Scopus rating (2010): SJR 0.151 SNIP 0.193
Scopus rating (2009): SJR 0.107 SNIP 0.022
Original language: English
Keywords: Engineering, Electrical Engineering, Physics, general, Biomedical Engineering, SC8, linear all-optical signal processing, micro-ring resonator (MRR), polarization diversity, silicon-on-insulator (SOI)
DOIs:
10.1007/s12200-016-0553-z
Source: FindIt
Source-ID: 2345227494
Research output: Research - peer-review > Journal article – Annual report year: 2016

Low-loss high-confinement waveguides and microring resonators in AlGaAs-on-insulator

AlGaAs is a promising material for integrated nonlinear photonics due to its intrinsic high nonlinearity. However, the challenging fabrication of deep etched AlGaAs devices makes it difficult to realize high-performance devices such as low-loss dispersion engineered waveguides and high quality microring resonators. Here, we report a process to make high-quality AlGaAs-on-insulator (AlGaAsOI) waveguides where high confinement waveguides can be realized. Using optimized patterning processes, we fabricated AlGaAsOI waveguides with propagation losses as low as 1 dB/cm and microring resonators with quality factors up to 350,000 at telecom wavelengths. Our demonstration opens new prospects for AlGaAs devices in integrated nonlinear photonics.

General information
Nonlinear Optics in AlGaAs on Insulator

AlGaAs on insulator is a powerful nonlinear platform sporting a high effective nonlinearity and the possibility to fabricate complex designs. We will present low loss waveguides enabling efficient optical signal processing and Kerr comb generation.

General information

State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices, Centre of Excellence for Silicon Photonics for Optical Communications, High-Speed Optical Communication
Contributors: Pu, M., Ottaviano, L., Semenova, E., Hu, H., Oxenløwe, L. K., Yvind, K.
Number of pages: 1
Publication date: 2016

Host publication information

Title of host publication: Integrated Photonics Research, Silicon and Nanophotonics 2016
Publisher: SPIE - International Society for Optical Engineering
ISBN (Print): 978-1-943580-14-9

Bibliographical note

From the session: Highly Nonlinear Optical Fibres and Nanowires (IM3A)
Source: PublicationPreSubmission
Source-ID: 125224337
Research output: Research - peer-review › Article in proceedings – Annual report year: 2016

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).

Optically pumped 1550nm wavelength tunable MEMS VCSEL
The paper presents the design and fabrication of an optically pumped 1550 nm tunable MEMS VCSEL with an enclosed MEMS. The MEMS is defined in SOI and the active material, an InP wafer with quantum wells are bonded to the SOI and the last mirror is made from the deposition of dielectric materials. The design brings in flexibility to fabricate MEMS VCSELs over a wider range of wavelengths. The paper discusses results from the simulations and bonding results from fabrication. The device will push the boundaries for wavelength sweep speed and bandwidth.

Optically pumped 1550 nm wavelength tunable MEMS VCSEL
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**Phase-sensitive Four-wave Mixing in AlGaAs-on-Insulator Nano-waveguides**

Phase-sensitive four-wave mixing is experimentally demonstrated in a 5-mm long AlGaAsOI nano-waveguide. More than 7 dB of phase-sensitive extinction ratio are reported without neither using active biasing nor polarization-assisted schemes. Measurements show a good match with numerical predictions.

**General information**

State: Published
Organisations: Department of Photonics Engineering, High-Speed Optical Communication, Centre of Excellence for Silicon Photonics for Optical Communications, Nanophotonic Devices
Contributors: Da Ros, F., Pu, M., Ottaviano, L., Hu, H., Semenova, E., Galili, M., Yvind, K., Oxenløwe, L. K.
Number of pages: 2
Publication date: 2016

**Host publication information**

Title of host publication: Proceedings of the 2016 IEEE Photonics Conference
Publisher: IEEE
Keywords: Four-wave mixing, Phase sensitive amplification, Integrated waveguides
Electronic versions:
DaRos_IPC16_submitted.pdf
Source: PublicationPreSubmission
Source-ID: 127459883
Research output: Research - peer-review › Article in proceedings – Annual report year: 2016

**Photonic crystal Fano structures and their application to ultrafast switching and lasers**

We present investigations on photonic-crystal Fano structures based on a cavitywaveguide configuration. We show that the use of Fano resonance can enable great improvements in high-speed low-energy all-optical switching and realizing ultra-fast nanolasers.

**General information**

State: Published
Organisations: Department of Photonics Engineering, Quantum and Laser Photonics, High-Speed Optical Communication, Nanophotonic Devices, Department of Micro- and Nanotechnology
Number of pages: 3
Publication date: 2016

**Host publication information**

Title of host publication: Proceedings of the 2016 Asia Communications and Photonics Conference
Publisher: Optical Society of America
ISBN (Electronic): 9780960038008
(Asia Communications and Photonics Conference, Acp).
DOIs:
10.1364/ACPC.2016.AF4C.2
Source: FindIt
Source-ID: 2370775195
Research output: Research - peer-review › Article in proceedings – Annual report year: 2016

**Single-Source AlGaAs Frequency Comb Transmitter for 661 Tbit/s Data Transmission in a 30-core Fiber**

We demonstrate an AlGaAs-on-insulator nano-waveguide-based frequency comb with high OSNR enabling a single-source to fully load a 9.6-km heterogeneous 30-core fibre with 661 Tbit/s data achieved by 30xcores, 80xWDM, 40 Gbaud, and PDM-16QAM
Supercontinuum Generation in AlGaAs-On-Insulator Nano-Waveguide at Telecom Wavelengths

We characterize pulse spectral broadening in an AlGaAs-on-insulator nano-waveguide at telecom wavelengths. We obtain a supercontinuum over 500 nm (30-dB bandwidth) with 410-fs pulses and self-phase modulation broadening covering the C-band with 1.1-ps pulses.

Switching dynamics in InP photonic-crystal nanocavity

In this paper, we presented switching dynamic investigations on an InP photonic-crystal (PhC) nanocavity structure using homodyne pump-probe measurements. The measurements were compared with simulations based on temporal nonlinear coupled mode theory and carrier rate equations for the dynamics of the carrier density governing the cavity properties. The results provide insight into the nonlinear optical processes that govern the dynamics of nanocavities.
Threshold Characteristics of Slow-Light Photonic Crystal Lasers
The threshold properties of photonic crystal quantum dot lasers operating in the slow-light regime are investigated experimentally and theoretically. Measurements show that, in contrast to conventional lasers, the threshold gain attains a minimum value for a specific cavity length. The experimental results are explained by an analytical theory for the laser threshold that takes into account the effects of slow light and random disorder due to unavoidable fabrication imperfections. Longer lasers are found to operate deeper into the slow-light region, leading to a trade-off between slow-light induced reduction of the mirror loss and slow-light enhancement of disorder-induced losses.

General information
State: Published
Organisations: Department of Photonics Engineering, Quantum and Laser Photonics, Nanophotonic Devices, Centre of Excellence for Silicon Photonics for Optical Communications
Contributors: Xue, W., Yu, Y., Ottaviano, L., Chen, Y., Semenova, E., Yvind, K., Mørk, J.
Number of pages: 5
Publication date: 2016
Peer-reviewed: Yes

Publication information
Journal: Physical Review Letters
Volume: 116
Issue number: 6
Article number: 063901
ISSN (Print): 0031-9007
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 7.58 SJR 3.622 SNIP 2.464
Web of Science (2017): Impact factor 8.839
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.33 SJR 4.196 SNIP 2.61
Web of Science (2016): Impact factor 8.462
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 5.76 SJR 4.656 SNIP 2.538
Web of Science (2015): Impact factor 7.645
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 6.62 SJR 5.232 SNIP 2.71
Web of Science (2014): Impact factor 7.512
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 7.46 SJR 5.675 SNIP 2.781
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 7.19 SJR 6.292 SNIP 2.867
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 7.02 SJR 6.314 SNIP 2.905
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 6.45 SNIP 2.757
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 6.325 SNIP 2.947
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 6.194 SNIP 2.837
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 5.95 SNIP 2.738
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 4.781 SNIP 2.443
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 4.082 SNIP 2.101
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 3.847 SNIP 2.122
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 4.661 SNIP 2.651
Web of Science (2003): Indexed yes
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 5.884 SNIP 3.375
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 5.618 SNIP 3.135
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 5.771 SNIP 2.941
Original language: English
Method for Generating a Compressed Optical Pulse

There is presented a method of generating a compressed optical pulse (112) comprising emitting from a wavelength tunable microcavity laser system (102), comprising an optical cavity (104) with a mechanically adjustable cavity length (L), a primary optical pulse (111) having a primary temporal width (T1) while adjusting the optical cavity length (L) so that said primary optical pulse comprises temporally separated photons of different wavelengths, and transmitting said pulse through a dispersive medium (114), so as to generate a compressed optical pulse (112) with a secondary temporal width (T2), wherein the secondary temporal width (T2) is smaller than the primary temporal width (T1).

General information

State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices
Contributors: Yvind, K.
Publication date: 21 May 2015

Publication information

IPC: H01S3/00, H01S3/105, H01S5/00, H01S5/183
Patent number: WO2015071379
Date: 21/05/2015
Priority date: 13/11/2013
Priority number: EP20130192702
Original language: English
Electronic versions:
WO2015071379A1.pdf

Bibliographical note

Also registered as: WO2014EP74535, EP20130192702
Source: espacenet
Source-ID: WO2015071379
Research output: Research › Patent – Annual report year: 2015

160-Gb/s Silicon All-Optical Packet Switch for Buffer-less Optical Burst Switching

We experimentally demonstrate a 160-Gb/s Ethernet packet switch using an 8.6-mm-long silicon nanowire for optical burst switching, based on cross phase modulation in silicon. One of the four packets at the bit rate of 160 Gb/s is switched by an optical control signal using a silicon based 1 × 1 all-optical packet switch. Error free performance (BER <1E-9) is achieved for the switched packet. The use of optical burst switching protocols could eliminate the need for optical buffering in silicon packet switch based optical burst switching, which might be desirable for high-speed interconnects within a short-reach and small-scale network, such as board-to-board interconnects, chip-to-chip interconnects, and on-chip interconnects.

General information

State: Published
Organisations: Department of Photonics Engineering, High-Speed Optical Communication, Nanophotonic Devices, Centre of Excellence for Silicon Photonics for Optical Communications
Contributors: Hu, H., Ji, H., Pu, M., Galili, M., Yvind, K., Oxenløwe, L. K.
Pages: 843-848
Publication date: 2015
Peer-reviewed: Yes

Publication information

Journal: Journal of Lightwave Technology
Volume: 33
Issue number: 4
ISSN (Print): 0733-8724
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
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<td>2003</td>
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<td>SJR 2.703, SNIP 2.876</td>
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A Highly Efficient Nonlinear Platform: AlGaAs-On-Insulator

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices
Contributors: Pu, M., Ottaviano, L., Semenova, E., Yvind, K.
Number of pages: 1
Publication date: 2015

Host publication information
Title of host publication: CLEO/Europe 2015 - European Conference on Lasers and Electro-Optics
Publisher: IEEE
ISBN (Print): 978-1-4673-7475-0
Source: PublicationPreSubmission
Source-ID: 112087651
Research output: Research - peer-review » Conference abstract in proceedings – Annual report year: 2015

AlGaAs-On-Insulator Nanowire with 750 nm FWM Bandwidth, -9 dB CW Conversion Efficiency, and Ultrafast Operation Enabling Record Tbaud Wavelength Conversion

We present an AlGaAs-on-insulator platform for integrated nonlinear photonics. We demonstrate the highest reported conversion efficiency/length/pump-power, ultra-broadband fourwave mixing, and first-ever wavelength conversion of 1.28-Tbaud serial data signals in a 3-mm long dispersion-engineered AlGaAs nano-waveguide

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices, High-Speed Optical Communication
Contributors: Pu, M., Ottaviano, L., Semenova, E., Vukovic, D., Oxenløwe, L. K., Yvind, K.
Number of pages: 3
Publication date: 2015

Host publication information
AlGaAs-On-Insulator nonlinear photonics
We present an AlGaAs-on-insulator platform for integrated nonlinear photonics. We demonstrate the highest reported conversion efficiency and ultra-broadband four-wave mixing for an integrated platform around 1550nm.

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. Photogenerated carriers are efficiently swept out by applying bias voltages, and a shortest carrier lifetime of only 55 ps is demonstrated.

Effective electro-optical modulation with high extinction ratio by a graphene-silicon microring resonator
Graphene opens up for novel optoelectronic applications thanks to its high carrier mobility, ultra-large absorption bandwidth, and extremely fast material response. In particular, the opportunity to control optoelectronic properties through tuning of the Fermi level enables electro-optical modulation, optical-optical switching, and other optoelectronics applications. However, achieving a high modulation depth remains a challenge because of the modest graphene-light interaction in the graphene-silicon devices, typically, utilizing only a monolayer or few layers of graphene. Here, we comprehensively study the interaction between graphene and a microring resonator, and its influence on the optical modulation depth. We demonstrate graphene-silicon microring devices showing a high modulation depth of 12.5 dB with a relatively low bias voltage of 8.8 V. On-off electro-optical switching with an extinction ratio of 3.8 dB is successfully demonstrated by applying a square-waveform with a 4 V peak-to-peak voltage.
Efficient silicon PIC mode multiplexer using grating coupler array with aluminum mirror for few-mode fiber

We demonstrate a silicon PIC mode multiplexer using grating couplers. An aluminum mirror is introduced for coupling efficiency improvement. A highest coupling efficiency of –10.6 dB with 3.7 dB mode dependent coupling loss is achieved.

Experimental demonstration of non-reciprocal transmission in a nonlinear photonic-crystal Fano structure

We suggest and experimentally demonstrate a photonic-crystal structure with more than 30 dB difference between forward and backward transmission levels. The non-reciprocity relies on the combination of ultrafast carrier nonlinearities and spatial symmetry breaking in a Fano structure employing a single nanocavity.
Flat-top Drop Filter based on a Single Topology Optimized Photonic Crystal Cavity

Outperforming conventional design concepts, a flat-top drop filter has been designed by applying 3D topology optimization to a single waveguide-coupled L3 photonic crystal cavity. Measurements on the design fabricated in silicon-on-insulator material reveal that the pass-band of the drop channel is flat within 0.44 dB over a wavelength range of 9.7 nm with an insertion loss lower than 0.85 dB.

Highly Efficient Four-Wave Mixing in an AlGaAs-On-Insulator (AlGaAsOI) Nano-Waveguide

We propose an AlGaAs-on-insulator platform for nonlinear integrated photonics. We demonstrate highly efficient four-wave mixing in a 3-mm long AlGaAs-on-insulator nanowaveguide. A conversion efficiency of -21.1 dB is obtained with only a 45-mW pump.

Highly Sensitive Photonic Crystal Cavity Laser Noise Measurements using Bayesian Filtering

We measure for the first time the frequency noise spectrum of a photonic crystal cavity laser with less than 20 nW of fiber-coupled output power using a coherent receiver and Bayesian filtering.
Hybrid vertical-cavity laser with lateral emission into a silicon waveguide

We experimentally demonstrate an optically-pumped III-V/Si vertical-cavity laser with lateral emission into a silicon waveguide. This on-chip hybrid laser comprises a distributed Bragg reflector, a III-V active layer, and a high-contrast grating reflector, which simultaneously funnels light into the waveguide integrated with the laser. This laser has the advantages of long-wavelength vertical-cavity surface-emitting lasers, such as low threshold and high side-mode suppression ratio, while allowing integration with silicon photonic circuits, and is fabricated using CMOS compatible processes. It has the potential for ultrahigh-speed operation beyond 100 Gbit/s and features a novel mechanism for transverse mode control.
III-V/SOI vertical cavity laser with in-plane output into a Si waveguide

We experimentally demonstrate an optically-pumped III-V-on-SOI hybrid vertical-cavity laser that outputs light into an in-plane Si waveguide, using CMOS-compatible processes. The laser operates at 1.49 μm with a side-mode suppression-ratio of 27 dB and has a similar threshold as long-wavelength VCSELs.

General information
State: Published
Organisations: Department of Photonics Engineering, Quantum and Laser Photonics, Nanophotonic Devices
Contributors: Park, G. C., Xue, W., Semenova, E., Yvind, K., Mørk, J., Chung, I.
Number of pages: 3
Publication date: 2015

Host publication information
Title of host publication: Proceedings of the Optical Fiber Communications Conference and Exhibition 2015
Publisher: IEEE
Article number: W2A.17
ISBN (Electronic): 978-1-55752-937-4
Electronic versions:
3_OFC_III_V_SOI_vertical_cavity_laser_with_Inplane_output_into_a_Si_waveguide.pdf
DOIs:
10.1364/OFC.2015.W2A.17

Bibliographical note
From the session: Poster I (W2A)
Source: PublicationPreSubmission
Source-ID: 107393368
Research output: Research - peer-review › Article in proceedings – Annual report year: 2015

Improvement of power characteristics in 850 nm quantum well laser with asymmetric barriers

Power and spectral characteristics of lasers with asymmetric barrier layers (ABLs) and a wide waveguide are studied. The use of ABLs reduces the saturation of light-current characteristic, associated with the parasitic recombination in the
Nonreciprocal transmission in a nonlinear photonic-crystal Fano structure with broken symmetry

Nanostructures that feature nonreciprocal light transmission are highly desirable building blocks for realizing photonic integrated circuits. Here, a simple and ultracompact photonic-crystal structure, where a waveguide is coupled to a single nanocavity, is proposed and experimentally demonstrated, showing very efficient optical diode functionality. The key novelty of the structure is the use of cavity-enhanced material nonlinearities in combination with spatial symmetry breaking and a Fano resonance to realize nonreciprocal propagation effects at ultralow power and with good wavelength tunability. The nonlinearity of the device relies on ultrafast carrier dynamics, rather than the thermal effects usually considered, allowing the demonstration of nonreciprocal operation at a bit-rate of 10 Gbit s−1 with a low energy consumption of 4.5 fJ bit−1.

General information
State: Published
Organisations: Department of Photonics Engineering, Quantum and Laser Photonics, High-Speed Optical Communication, Nanophotonic Devices
Contributors: Yu, Y., Chen, Y., Hu, H., Xue, W., Yvind, K., Mørk, J.
Pages: 241–247
Publication date: 2015
Peer-reviewed: Yes

Publication information
Journal: Laser & Photonics Reviews
Volume: 9
Issue number: 2
ISSN (Print): 1863-8880
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 9.02 SJR 4.228 SNIP 2.988
Web of Science (2017): Impact factor 8.529
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 8.71 SJR 4.013 SNIP 3.351
Web of Science (2016): Impact factor 8.434
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 8.54 SJR 4.205 SNIP 3.479
Web of Science (2015): Impact factor 7.486
Silicon nanowires for ultra-fast and ultrabroadband optical signal processing

In this paper, we present recent research on silicon nanowires for ultra-fast and ultra-broadband optical signal processing at DTU Fotonik. The advantages and limitations of using silicon nanowires for optical signal processing are revealed through experimental demonstrations of various optical signal processing.

General information
State: Published
Organisations: Department of Photonics Engineering, High-Speed Optical Communication, Nanophotonic Devices, Centre of Excellence for Silicon Photonics for Optical Communications, Department of Micro- and Nanotechnology
Contributors: Ji, H., Hu, H., Pu, M., Ding, Y., Jensen, A. S., Galili, M., Yvind, K., Oxenløwe, L. K.
Number of pages: 3
Pages: 1-3
Publication date: 2015

Host publication information
Title of host publication: 2015 Opto-Electronics and Communications Conference (OECC)
Place of publication: 9781467379441
Publisher: IEEE
Keywords: Communication, Networking and Broadcast Technologies, Fields, Waves and Electromagnetics, Photonics and Electrooptics, Adaptive optics, Bit error rate, Integrated optics, Nonlinear optics, Optical pumping, Optical waveguides, Silicon
DOIs:
Slow-light effects in photonic crystal membrane lasers
In this paper, we present a systematic investigation of photonic crystal cavity laser operating in the slow-light regime. The dependence of lasing threshold on the effect of slow-light will be particularly highlighted.

Suppression of sublinearity of light–current curve in 850 nm quantum well laser with asymmetric barrier layers
An AlGaAs/GaAs quantum well (QW) laser is fabricated with GaInP and AlGaInAs asymmetric barrier layers (ABLs) and its light–current characteristic (LCC) is compared with that of a reference conventional QW laser without ABLs. It was found that the use of the ABLs suppresses the sublinearity of the LCC at high current densities. As a result, the maximum lasing power of 9.2 W, being limited by catastrophic optical mirror damage, is achieved at a considerably lower operating current in the laser with ABLs as compared to the reference laser (12.5 against 20.2 A). The ABL effect is associated with the suppression of the parasitic recombination in the optical confinement layer, as confirmed by a decrease of the intensity of the spontaneous emission from the layer.
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.35 SJR 0.402 SNIP 0.86
Web of Science (2016): Impact factor 1.155
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 1.31 SJR 0.47 SNIP 0.959
Web of Science (2015): Impact factor 0.854
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 1.31 SJR 0.5 SNIP 1.024
Web of Science (2014): Impact factor 0.93
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 1.45 SJR 0.544 SNIP 1.108
Web of Science (2013): Impact factor 1.068
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 1.45 SJR 0.588 SNIP 1.12
Web of Science (2012): Impact factor 1.038
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 1.44 SJR 0.605 SNIP 1.08
Web of Science (2011): Impact factor 0.965
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.603 SNIP 0.971
Web of Science (2010): Impact factor 1.004
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.665 SNIP 1.036
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 0.789 SNIP 0.944
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.887 SNIP 1.173
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.83 SNIP 1.171
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.014 SNIP 1.27
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 1.103 SNIP 1.31
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 1.278 SNIP 1.316
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 1.307 SNIP 1.189
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 1.542 SNIP 1.025
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 1.559 SNIP 0.926
The effect of asymmetric barrier layers in the waveguide region on power characteristics of QW lasers

Current-voltage and light-current characteristics of quantum-well lasers have been studied at high drive currents. The introduction of asymmetric barrier layers adjacent to the active region caused a significant suppression of the nonlinearity in the light-current characteristic and an increase in the external differential efficiency. As a result, the maximum wallplug efficiency increased by 9%, while the output optical power increased by 29%.

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices, St. Petersburg Academic University, Virginia Polytechnic Institute and State University
Number of pages: 4
Pages: 439-442
Publication date: 2015
Peer-reviewed: Yes

Publication information
Journal: Technical Physics Letters
Volume: 41
Issue number: 5
ISSN (Print): 1063-7850
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 0.86 SJR 0.469 SNIP 1.019
Web of Science (2017): Impact factor 0.808
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.81 SJR 0.416 SNIP 0.985
Web of Science (2016): Impact factor 0.771
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 0.73 SJR 0.421 SNIP 0.945
Web of Science (2015): Impact factor 0.702
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 0.64 SJR 0.399 SNIP 0.817
Web of Science (2014): Impact factor 0.574
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 0.57 SJR 0.386 SNIP 0.752
Web of Science (2013): Impact factor 0.583
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 0.47 SJR 0.365 SNIP 0.658
Web of Science (2012): Impact factor 0.562
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
Thermal analysis of line-defect photonic crystal lasers

We report a systematic study of thermal effects in photonic crystal membrane lasers based on line-defect cavities. Two material platforms, InGaAsP and InP, are investigated experimentally and numerically. Lasers with quantum dot layers embedded in an InP membrane exhibit lasing at room temperature under CW optical pumping, whereas InGaAsP membranes only lase under pulsed conditions. By varying the duty cycle of the pump beam, we quantify the heating induced by optical pumping in the two material platforms and compare their thermal properties. Full 3D finite element simulations show the spatial temperature profile and are in good agreement with the experimental results concerning the thermal tolerance of the two platforms.

General information
State: Published
Organisations: Department of Photonics Engineering, Quantum and Laser Photonics, Nanophotonic Devices
Contributors: Xue, W., Ottaviano, L., Chen, Y., Semenova, E., Yu, Y., Lupi, A., Mørk, J., Yvind, K.
Pages: 18277-18287
Publication date: 2015
Peer-reviewed: Yes

Publication information
Journal: Optics Express
Volume: 23
Issue number: 14
ISSN (Print): 1094-4087
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.74 SJR 1.519 SNIP 1.567
Web of Science (2017): Impact factor 3.356
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.48 SJR 1.532 SNIP 1.544
Web of Science (2016): Impact factor 3.307
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 3.78 SJR 1.91 SNIP 1.674
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 4.18 SJR 2.313 SNIP 2.124
Web of Science (2014): Impact factor 3.488
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 4.38 SJR 2.337 SNIP 2.196
Web of Science (2013): Impact factor 3.525
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 3.85 SJR 2.562 SNIP 2.108
Web of Science (2012): Impact factor 3.546
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 4.04 SJR 2.58 SNIP 2.572
Web of Science (2011): Impact factor 3.587
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.906 SNIP 2.428
Web of Science (2010): Impact factor 3.753
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 3.039 SNIP 2.679
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 3.204 SNIP 2.423
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 3.284 SNIP 2.11
Web of Science (2007): Indexed yes
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 3.313 SNIP 2.336
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 2.819 SNIP 2.472
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 2.669 SNIP 2.217
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 1.745 SNIP 1.748
Web of Science (2002): Indexed yes
Topology Optimization of Coupled Photonic Crystal Cavities for Flat-top Drop Filter Functionality

The field of photonic integrated circuits (PICs) has attracted interest in recent years as they allow high device density while requiring only low operating power. The possibility of exploiting mode division multiplexing (MDM) in future optical communication networks is being investigated as a potential method for supporting the constantly increasing internet traffic demand [1]. Mode converters are important components necessary to support on-chip processing of MDM signals and multiple approaches have been followed in realizing such devices [2], [3]. Topology optimization (TO) [4] is a powerful inverse design tool which has experimentally proven to deliver robust designs with controllable bandwidth and low loss [5], [6]. Here it is shown how TO has been used to obtain a small footprint, low-loss, broad-band design for mode conversion between the transverse electric fundamental even (TE0) mode and the first higher order odd mode (TE1) in a photonic wire. The design is to be fabricated in silicon-on-insulator (SOI) material, and previous work has shown excellent correspondence between simulations and experimental results for 3D TO [7].

Topology optimized design for silicon-on-insulator mode converter

The field of photonic integrated circuits (PICs) has attracted interest in recent years as they allow high device density while requiring only low operating power. The possibility of exploiting mode division multiplexing (MDM) in future optical communication networks is being investigated as a potential method for supporting the constantly increasing internet traffic demand [1]. Mode converters are important components necessary to support on-chip processing of MDM signals and multiple approaches have been followed in realizing such devices [2], [3]. Topology optimization (TO) [4] is a powerful inverse design tool which has experimentally proven to deliver robust designs with controllable bandwidth and low loss [5], [6]. Here it is shown how TO has been used to obtain a small footprint, low-loss, broad-band design for mode conversion between the transverse electric fundamental even (TE0) mode and the first higher order odd mode (TE1) in a photonic wire. The design is to be fabricated in silicon-on-insulator (SOI) material, and previous work has shown excellent correspondence between simulations and experimental results for 3D TO [7].
**Topology-optimized silicon photonic wire mode (de)multiplexer**

We have designed and for the first time experimentally verified a topology optimized mode (de)multiplexer, which demultiplexes the fundamental and the first order mode of a double mode photonic wire to two separate single mode waveguides (and multiplexes vice versa). The device has a footprint of \( \sim 4.4 \text{ μm} \times \sim 2.8 \text{ μm} \) and was fabricated for different design resolutions and design threshold values to verify the robustness of the structure to fabrication tolerances. The multiplexing functionality was confirmed by recording mode profiles using an infrared camera and vertical grating couplers. All structures were experimentally found to maintain functionality throughout a 100 nm wavelength range limited by available laser sources and insertion losses were generally lower than 1.3 dB. The cross talk was around -12 dB and the extinction ratio was measured to be better than 8 dB.

**Ultra-compact Higher-Order-Mode Pass Filter in a Silicon Waveguide**

An 3.7 μm long higher-order-mode pass filter with an extinction ratio larger than 20 dB is demonstrated in a 1D corrugated silicon multimode waveguide.
Ultrafast all-optical modulation using a photonic-crystal Fano structure with broken symmetry

We experimentally demonstrate ultrafast all-optical modulation using an ultracompact InP photonic-crystal Fano structure. In contrast to symmetric configurations previously considered, the use of a structure with broken symmetry in combination with a well-engineered Fano resonance is shown to suppress patterning effects as well as lower the energy consumption. These properties enable the achievement of error-free 10 Gbit/s modulation with low pump energy using realistic pseudorandom binary sequence patterns. At 20 Gbit/s, the bit error ratio remains well below the limit for forward error correction.
Ultrafast low-energy all-optical switching using a photonic-crystal asymmetric Fano structure

We experimentally demonstrate 20 Gbit/s all-optical switching with low-energy consumption using a simple and ultra-compact InP photonic-crystal structure by employing a well-engineered Fano resonance in combination with broken mirror symmetry.

General information
State: Published
Organisations: Department of Photonics Engineering, Quantum and Laser Photonics, High-Speed Optical Communication, Department of Micro- and Nanotechnology, Nanophotonic Devices
Contributors: Yu, Y., Hu, H., Oxenløwe, L. K., Yvind, K., Mørk, J.
Pages: 94-96
Publication date: 2015

Host publication information
Title of host publication: Proceedings of 2015 International Conference on Photonics in Switching
Publisher: IEEE
ISBN (Print): 9781479988211
Keywords: Communication, Networking and Broadcast Technologies, Components, Circuits, Devices and Systems, Computing and Processing, Engineered Materials, Dielectrics and Plasmas, Fields, Waves and Electromagnetics, Photonics and Electrooptics, Signal Processing and Analysis, All-optical devices, Nonlinear optical devices, Photonic crystals
Electronic versions: 4_PS_2015_.pdf
DOIs:

We present a record-low threshold power of 7 mW at ~1.55 µm for on-chip optical parametric oscillation using a high quality factor micro-ring-resonator in a new nonlinear photonics platform: AlGaAs-on-insulator.

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices, High-Speed Optical Communication
Contributors: Pu, M., Ottaviano, L., Semenova, E., Oxenløwe, L. K., Yvind, K.
Number of pages: 2
Publication date: 2015

Host publication information
Title of host publication: Proceedings of 2015 Conference on Lasers and Electro-Optics (CLEO)
Publisher: IEEE
Article number: JTh5A.9
DOIs:
10.1364/cleo_at.2015.jth5a.9
Source: PublicationPreSubmission
Source-ID: 108590197
Research output: Research - peer-review » Article in proceedings – 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
Contributors: Ji, H., Hu, H., Ding, Y., Ou, H., Yvind, K., Oxenløwe, L. K.
Number of pages: 3
Publication date: 2015

Host publication information
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
Electronic versions:
3_OFCC2015_JH_640_Nyquist_OTDM_DPSK_AOWC_in_Silicon_Nanowire.pdf
DOIs:
10.1364/OfC.2015.Tu2F.2
Source: PublicationPreSubmission
Source-ID: 110726037
Research output: Research - peer-review » Article in proceedings – Annual report year: 2015

A wavelength tunable photon source with sealed inner volume.

There is presented a method of providing a wavelength tunable photon source (200), comprising bonding a first element (101) with a first mirror (106), a second element (102) with a second mirror (108) and a third element (103) with a photon emitter together in a structure enclosing an inner volume (214) being a sealed volume, and forming a bonding interface (212) which is gas-tight, so that the first mirror (106) is placed in the inner volume (214) so the first mirror (106) may move within the inner volume (214). The method provides a relatively simple way of obtaining a tunable photon source where the inner volume is sealed. The invention furthermore relates to a corresponding photon source, and use of such photon source.

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices
All-optical signal processing using InP photonic-crystal nanocavity switches

In this paper, we present recent progress in experimental characterization of InP photonic-crystal nanocavity switches. Pump-probe measurements on an InP PhC H0 cavity show large-contrast ultrafast switching at low pulse energy. At large pulse energies, a large resonance shift passing across the probe leads to pulse broadening. In addition, high-frequency carrier density oscillations can be induced, leading to pulse splitting. Excellent agreements between simulations and experiments are obtained when employing a carrier rate equation model containing three relaxation times, accounting for the joint effects of fast carrier diffusion, slow surface and bulk recombination. Utilizing the simple InP PhC nanocavity structure, we successfully demonstrate 10-Gb/s RZ-OOK all-optical modulation with low energy consumption.

All-Optical Signal Processing using Silicon Devices

This paper presents an overview of recent work on the use of silicon waveguides for processing optical data signals. We will describe ultra-fast, ultra-broadband, polarisation-insensitive and phase-sensitive applications including processing of spectrally-efficient data formats and optical phase regeneration.
Butt-joint integration of active optical components based on InP/AlInGaAsP alloys

We demonstrate all-active planar high quality butt-joint (BJ) integration of a QW Semiconductor Optical Amplifier (SOA) and MQW Electro-Absorption Modulator (EAM) based on an InP/AlInGaAsP platform. The degradation of the optical properties in the vicinity of ~1 μm to the BJ interface was determined by means of μPL measurements.

General information
State: Published
Organisations: Nanophotonic Devices, Department of Photonics Engineering
Contributors: Kulkova, I., Kuznetsova, N., Semenova, E., Yvind, K.
Pages: 1-2
Publication date: 2014

Host publication information
Title of host publication: Proceedings of the 26th International Conference on Indium Phosphide and Related Materials
Publisher: IEEE
ISBN (Print): 97814799957293
Keywords: electro-optical modulation, electroabsorption, III-V semiconductors, indium compounds, integrated optics, photoluminescence, quantum well lasers, semiconductor optical amplifiers, Components, Circuits, Devices and Systems, Photonics and Electrooptics, active optical components, Al(role int), Al(role ss), AllnGaAsP(role int), AllnGaAsP(role ss), all-active planar high quality butt-joint integration, As(role int), As(role ss), BJ interface, EAM, Ga(role int), Ga(role ss), In(role int), In(role ss), Indium gallium arsenide, Indium phosphide, InP(role int), InP(role ss), InP-AllnGaAsP, InP-AllnGaAsP(role int), InP/AllnGaAsP alloys, Laser mode locking, MQW Electro-Absorption Modulator, optical properties, Optical reflection, P(role int), P(role ss), Quantum well devices, QW Semiconductor Optical Amplifier, Semiconductor optical amplifiers, SOA, μPL measurements
DOIs: 10.1109/ICIPRM.2014.6880579
Source: FindIt
Source-ID: 270316285
Research output: Research - peer-review › Article in proceedings – Annual report year: 2014

Crystalllographic dependent in-situ CBr4 selective nano-area etching and local regrowth of InP/InGaAs by MOVPE

Selective area etching and growth in the metalorganic vapor phase epitaxy (MOVPE) reactor on nano-scale structures have been examined. Using different mask orientations, crystallographic dependent etching of InP can be observed when carbon tetrabromide (CBr4) is used as an etchant. Scanning Electron Microscopy (SEM) investigation of etch profiles showed formation of a U-shaped groove along the [01̄1̄] direction, terminated by {111}B planes with an ~15nm (100) plateau and transitional {311}B planes, developed in a self-limiting manner. In the perpendicular direction [01̄1], etching with a dominant lateral component driven by fast etched {111}A and {311}A side planes was observed. A directly grown single InGaAs QW in the etched grooves demonstrated different QW profiles: a crescent-shaped on {311}B and {100} planes (along the [01̄1̄] direction) and two separated quarter-circle curvatures grown preferably on {311}A along [01̄1]. Room temperature micro-photoluminescence measurements indicated a wavelength red-shift in over 125nm along [01̄1] comparing to [01̄1], which is related to both growth enhancement and composition variation of the grown material.

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices, Center for Electron Nanoscopy, St. Petersburg Academic University
Contributors: Kuznetsova, N., Kulkova, I., Semenova, E., Kadkhodazadeh, S., Kryzhanovskaya, N., Zhukov, A., Yvind, K.
Pages: 111-115
Publication date: 2014
Peer-reviewed: Yes

Publication information
Journal: Journal of Crystal Growth
Volume: 406
ISSN (Print): 0022-0248
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Original language: English

Electrical Injection Schemes for Nanolasers

Three electrical injection schemes based on recently demonstrated electrically pumped photonic crystal nanolasers have been numerically investigated: 1) a vertical p-i-n junction through a post structure; 2) a lateral p-i-n junction with a homostructure; and 3) a lateral p-i-n junction with a buried heterostructure. Self-consistent laser-diode simulations reveal that the lateral injection scheme with a buried heterostructure achieves the best lasing characteristics at a low current, whereas the vertical injection scheme performs better at a higher current for the chosen geometries. For this analysis, the properties of different schemes, i.e., electrical resistance, threshold voltage, threshold current, and internal efficiency as energy requirements for optical interconnects are compared and the physics behind the differences is discussed.

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices, Quantum and Laser Photonics
Contributors: Lupi, A., Chung, I., Yvind, K.
Pages: 330-333
Publication date: 2014
Peer-reviewed: Yes

Publication information
Journal: IEEE Photonics Technology Letters
Volume: 26
Issue number: 4
ISSN (Print): 1041-1135
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 2.84 SJR 0.961 SNIP 1.25
Web of Science (2017): Impact factor 2.446
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.52 SJR 0.989 SNIP 1.224
Web of Science (2016): Impact factor 2.375
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 2.62 SJR 1.19 SNIP 1.266
Web of Science (2015): Impact factor 1.945
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 2.78 SJR 1.421 SNIP 1.583
Web of Science (2014): Impact factor 2.11
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 2.95 SJR 1.495 SNIP 1.548
Web of Science (2013): Impact factor 2.176
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 2.46 SJR 1.647 SNIP 1.694
Web of Science (2012): Impact factor 2.038
ISI indexed (2012): ISI indexed yes
The development of epitaxial technology for the fabrication of quantum dot (QD) gain material operating in the 1.55 μm wavelength range is a key requirement for the evolution of telecommunication. High performance QD material demonstrated on GaAs only covers the wavelength region 1-1.35 μm. In order to extract the QD benefits for the longer telecommunication wavelength range the technology of QD fabrication should be developed for InP based materials. In our work, we take advantage of both QD fabrication methods Stranski-Krastanow (SK) and selective area growth (SAG) employing block copolymer lithography. Due to the lower lattice mismatch of InAs/InP compared to InAs/GaAs, InP based QDs have a larger diameter and are shallower compared to GaAs based dots. This shape causes low carrier localization and small energy level separation which leads to a high threshold current, high temperature dependence, and low laser quantum efficiency. Here, we demonstrate that with tailored growth conditions, which suppress surface migration of adatoms during the SK QD formation, much smaller base diameter (13.6nm versus 23nm) and an improved aspect ratio are achieved. In order to gain advantage of non-strain dependent QD formation, we have developed SAG, for which the growth occurs only in the nano-openings of a mask covering the wafer surface. In this case, a wide range of QD composition can be chosen. This method yields high purity material and provides significant freedom for reducing the aspect ratio of QDs with the possibility to approach an ideal QD shape.
Fano resonance control in a photonic crystal structure and its application to ultrafast switching
We experimentally demonstrate a photonic crystal structure that allows easy and robust control of the Fano spectrum. Its operation relies on controlling the amplitude of light propagating along one of the light paths in the structure from which the Fano resonance is obtained. Short-pulse dynamic measurements show that besides drastically increasing the switching contrast, the transmission dynamics itself is strongly affected by the nature of the resonance. The influence of slow-recovery tails implied by a long carrier lifetime can thus be reduced using a Fano resonance due to a hitherto unrecognized reshaping effect of the nonlinear Fano transfer function. As an example, we present a system application of a Fano structure, demonstrating its advantages by the experimental realization of 10 Gbit/s all-optical modulation with optical control power less than 1mW.

General information
State: Published
Organisations: Department of Photonics Engineering, Quantum and Laser Photonics, High-Speed Optical Communication, Nanophotonic Devices
Number of pages: 6
Pages: 061117
Publication date: 2014
Peer-reviewed: Yes
Early online date: 2014

Publication information
Volume: 105
Issue number: 6
ISSN (Print): 0003-6951
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.25 SJR 1.382 SNIP 1.167
Web of Science (2017): Impact factor 3.495
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.67 SJR 1.673 SNIP 1.249
Web of Science (2016): Impact factor 3.411
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 2.47 SJR 1.499 SNIP 1.226
Web of Science (2015): Impact factor 3.142
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 3.25 SJR 1.861 SNIP 1.492
Web of Science (2014): Impact factor 3.302
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 3.77 SJR 2.146 SNIP 1.633
Web of Science (2013): Impact factor 3.515
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
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
Contributors: Ding, Y., Ou, H., Peucheret, C., Yvind, K.
Number of pages: 3
Pages: 1-3
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.
High-quality MOVPE butt-joint integration of InP/AlGaInAs/InGaAsP-based all-active optical components

In this paper, we demonstrate the applicability of MOVPE butt-joint regrowth for integration of all-active InP/AlGaInAs/InGaAsP optical components and the realization of high-functionality compact photonic devices. Planar high-quality integration of semiconductor optical amplifiers of various epi-structures with a multi-quantum well electro-absorption modulator has been successfully performed and their optical and crystalline quality was experimentally investigated. The regrown multi-quantum well material exhibits a slight bandgap blue-shift of less than 20 meV, when moving away from the regrowth interface. In closest vicinity to the mask, the growth profile revealed a bent-up shape which is associated with an increase in the bandgap energy resulting from the combined effect of growth rate suppression and higher Ga concentration. This increase in bandgap energy makes the interface partially transparent (thus beneficial for unaffected light transmission) and forces carriers away from possible interfacial defects. The internal reflectivity below 2.1×10^-5 ensures minimization of detrimental intracavity feedback.
Hybrid Light-Emitting Diode Enhanced With Emissive Nanocrystals

This thesis investigates a new type of white light emitting hybrid diode, composed of a light emitting GaN/InGaN LED and a layer of semiconductor nanocrystals for color conversion. Unlike standard white LEDs, the device is configured to achieve high color conversion efficiency via non-radiative energy transfer from the primary LED to the nanocrystals.

LED structures with sub-10 nm separation the between quantum well and the surface and patterned standard bright LEDs are considered for the hybrid devices, which require close proximity of the nanocrystals to the quantum well. The development of the hybrid diode fabrication including process techniques for GaN LED and incorporation of the nanocrystals are presented with the emphasis on the differences with standard LED processing.

Results and analysis of optical and electrical characterization including photoluminescence (PL), micro-PL, time-resolved PL and electroluminescence (EL) together with current-voltage characteristics are presented to evaluate the device performance. A clear evidence of non-radiative energy transfer was seen in the carrier dynamics of both the LED and the nanocrystals when the quantum well – nanocrystals separation was less than 10nm. Analysis of the results shows that in order to achieve sufficient for the white LED color conversion, better surface passivation and nanocrystals with shorter exciton lifetimes and weaker Auger recombination and needed.

General information
State: Published
Organisations: Programmable Phase Optics, Department of Photonics Engineering, Nanophotonic Devices
Contributors: Kopylov, O., Yvind, K., Kardynal, B.
Number of pages: 193
Publication date: 2014
Influence of thermal effects induced by nonlinear absorption on four-wave mixing in silicon waveguides

Influence of thermal effects induced by nonlinear absorption on four-wave mixing in silicon waveguides is investigated. A conversion bandwidth reduction up to 63% is observed in simulation due to the thermal effects.

Low-power 10 Gbit/s RZ-OOK all-optical modulation using a novel photonic-crystal Fano switch

We demonstrate a novel photonic-crystal nanocavity switch based on a Fano resonance. Compared to conventional structures with Lorentzian lineshape, the Fano resonance reduces the switching energy and suppresses patterning effects, allowing experimental demonstration of 10 Gbit/s RZ-OOK all-optical modulation with input powers less than 1 mW.
This thesis is devoted to the materials engineering for semiconductor monolithic passively mode-locked lasers (MLLs) as a compact energy-efficient source of ultrashort optical pulses. Up to the present day, the achievement of low-noise sub-picosecond pulse generation has remained a challenge. This work has considered the role of the combined ultrafast gain and absorption dynamics in MLLs as a main factor limiting laser performance. An independent optimization of MLL amplifier and saturable absorber active materials was performed. Two promising approaches were considered: quantum dot (QD) or single quantum well (QW) amplifier in tandem with a fast multi-QW electroabsorption modulator (EAM) based on the InP/AlGaInAs/InGaAsP platform for operation in the 1.55 μm telecommunications range.

A butt-joint MOVPE regrowth technique was established for monolithic integration showing high crystalline quality and low internal reflection compatible with the severe requirements of monolithic MLLs. Experimental characterization of static material parameters of the fabricated devices revealed QW-like gain behavior of a self-assembled InAs/InP QD material and low internal efficiency which limited its application in MLLs. Improved QW laser performance was demonstrated using the asymmetric barrier layer approach. The analysis of the gain characteristics showed that the high population inversion beneficial for noise reduction cannot be achieved for 10 GHz QW MLLs and would have required lowering the modal gain or utilizing an extended cavity design. The offset QW design was introduced. The performance of 10 GHz passively MLLs consisting of integrated QW gain section with MQW EAM was demonstrated to allow for 890 fs pulse generation with reduced timing jitter compared to non-integrated QW MLLs owing to the fast EAM recovery.

Nonlinear switching dynamics in a photonic-crystal nanocavity

We report the experimental observation of nonlinear switching dynamics in an InP photonic crystal nanocavity. Usually, the regime of relatively small cavity perturbations is explored, where the signal transmitted through the cavity follows the temporal variation of the cavity resonance. When the cavity is perturbed by strong pulses, we observe several nonlinear effects, i.e., saturation of the switching contrast, broadening of the switching window, and even initial reduction of the transmission. The effects are analyzed by comparison with nonlinear coupled mode theory and explained in terms of large dynamical variations of the cavity resonance in combination with nonlinear losses. The results provide insight into the nonlinear optical processes that govern the dynamics of nanocavities and are important for applications in optical signal processing, where one wants to optimize the switching contrast.
Nonplanar nanoselective area growth of InGaAs/InP

In this study, we have investigated metal-organic vapor phase epitaxial nano-patterned selective area growth of InGaAs/InP on non-planar (001) InP surfaces. Due to high etching resistance and the small molecular size of negative tone electron beam HSQ resist, the protection mask formed in HSQ has small feature sizes in ten nanometers scale and allow realization of in-situ etching. As was observed in the SAG regime, in-situ etching of InP by carbon tetrabromide leads to formation of self-limited structures. By altering etching time, the groove shape can be changed from a triangular trench to a trapeze. Another appealing aspect of in situ etching is that the shape of InGaAs can be tuned from a crescent to a triangle or a line by varying growth parameters. Quantum well wires can be fabricated by growing directly in the bottom of V-shaped groove. In addition, changes of mask orientations lead to anisotropic or isotropic character of etching. The investigated technique of nano-patterned selective area growth allows obtaining different profiles of structures and different quantum structures such as quantum well or wires in the same growth run. To investigate the shape and crystalline quality of the active material, the cross-sectional geometry was observed by field emission scanning electron microscopy and scanning transmission electron microscopy. The optical properties were carried out at room temperature using micro-photoluminescence setup. The results showed different deposition rates for openings oriented along [0-11] and [0-1-1] directions with higher rate along [0-1-1]. The fabricated active material was incorporated into photonic crystal waveguides.
On-chip wavelength switch based on thermally tunable discrete four-wave mixing in a silicon waveguide

An on-chip wavelength switch is proposed based on discrete four-wave mixing in a silicon waveguide. Switching operation can be realized by thermal tuning the waveguide dispersion. We also discuss optimal dimension design concerning device performances.

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices, Quantum and Laser Photonics, High-Speed Optical Communication
Contributors: Pu, M., Chen, Y., Hu, H., Yvind, K.
Pages: 332-333
Publication date: 2014

Host publication information
Title of host publication: Proceedings of 2014 IEEE Photonics Conference
Publisher: IEEE
ISBN (Print): 9781457715044
Keywords: Photonics and Electrooptics, Dispersion, Four-wave mixing, Nonlinear optics, Optical switches, Optical waveguides, Photonics, Silicon, Silicon Photonics, System-on-chip, Wavelength division multiplexing, Wavelength-selective conversion
DOIs: 10.1109/IPCon.2014.6995379
Resonance Energy Transfer in Hybrid Devices in the Presence of a Surface

We have studied room-temperature, nonradiative resonant energy transfer from InGaN/GaN quantum wells to CdSe/ZnS nanocrystals separated by aluminum oxide layers of different thicknesses. Nonradiative energy transfer from the quantum wells to the nanocrystals at separation distances of up to approximately 10 nm was observed. By comparing the carrier dynamics of the quantum wells and the nanocrystals, we found that nonradiative recombination via surface states, generated during dry etching of the wafer, counteracts the nonradiative energy-transfer process to the nanocrystals and therefore decreases the process efficiency.

General information
State: Published
Organisations: Department of Photonics Engineering, Programmable Phase Optics, Department of Physics, Quantum Physics and Information Technology, Center for Electron Nanoscopy, Nanophotonic Devices
Contributors: Kopylov, O., Huck, A., Kadkhodazadeh, S., Yvind, K., Kardynal, B.
Pages: 16284 − 16289
Publication date: 2014
Peer-reviewed: Yes

Publication information
Journal: Journal of Physical Chemistry Part C: The Nanomaterials and Interfaces
Volume: 118
ISSN (Print): 1932-7447
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 4.58 SJR 2.135 SNIP 1.147
Web of Science (2017): Impact factor 4.484
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 4.48 SJR 1.964 SNIP 1.195
Web of Science (2016): Impact factor 4.536
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 4.68 SJR 1.886 SNIP 1.26
Web of Science (2015): Impact factor 4.509
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 5.08 SJR 2.032 SNIP 1.447
Web of Science (2014): Impact factor 4.772
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 5.14 SJR 2.143 SNIP 1.445
Web of Science (2013): Impact factor 4.835
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 4.98 SJR 2.529 SNIP 1.461
Web of Science (2012): Impact factor 4.814
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Saturation broadening effect in an InP photonic-crystal nanocavity switch

Pump-probe measurements on InP photonic-crystal nanocavities show large-contrast fast switching at low pulse energy. For large pulse energies, large resonance shifts passing across the probe lead to switching contrast saturation and switching time-window broadening. © 2014 OSA.

General information
State: Published
Organisations: Department of Photonics Engineering, Quantum and Laser Photonics, High-Speed Optical Communication, Nanophotonic Devices
Contributors: Yu, Y., Palushani, E., Heuck, M., Vukovic, D., Peucheret, C., Yvind, K., Mørk, J.
Number of pages: 2
Publication date: 2014

Host publication information
Title of host publication: Proceedings of 2014 Conference on Lasers and Electro-Optics (CLEO)
Publisher: IEEE
ISBN (Print): 97815557529992
(Optics Infobase Conference Papers).
Keywords: Instrumentation, Atomic and Molecular Physics, and Optics, Fast switching, Low pulse energy, Nano-cavities, Pulse energies, Pump probe measurement, Resonance shift, Saturation broadening, Switching contrast, Probes
Source: FindIt
Source-ID: 2201198910
Research output: Research - peer-review > Journal article – Annual report year: 2014

Slow-light-enhanced gain in active photonic crystal waveguides

Passive photonic crystals have been shown to exhibit a multitude of interesting phenomena, including slow-light propagation in line-defect waveguides. It was suggested that by incorporating an active material in the waveguide, slow light could be used to enhance the effective gain of the material, which would have interesting application prospects, for example enabling ultra-compact optical amplifiers for integration in photonic chips. Here we experimentally investigate the gain of a photonic crystal membrane structure with embedded quantum wells. We find that by solely changing the photonic crystal structural parameters, the maximum value of the gain coefficient can be increased compared with a ridge waveguide structure and at the same time the spectral position of the peak gain can be controlled. The experimental results are in qualitative agreement with theory and show that gain values similar to those realized in state-of-the-art
semiconductor optical amplifiers should be attainable in compact photonic integrated amplifiers
Temporal dynamics of all-optical switching in Photonic Crystal Cavity
The temporal dynamics of all-optical switching has been investigated in a Photonic Crystal Cavity with a 150fs-40aJ/pulse resolution. This allowed observing for the first time effects like pulse reshaping, pulse delay and intra-cavity Four-Wave-Mixing.

Topology optimized mode conversion in a photonic crystal waveguide fabricated in silicon-on-insulator material
We have designed and for the first time experimentally verified a topology optimized mode converter with a footprint of ∼6.3 μm × ∼3.6 μm which converts the fundamental even mode to the higher order odd mode of a dispersion engineered photonic crystal waveguide. 2D and 3D topology optimization is utilized and both schemes result in designs theoretically showing an extinction ratio larger than 21 dB. The 3D optimized design has an experimentally estimated insertion loss lower than ∼2 dB in an ∼43 nm bandwidth. The mode conversion is experimentally confirmed in this wavelength range by recording mode profiles using vertical grating couplers and an infrared camera. The experimentally determined extinction ratio is > 12 dB and is believed to be limited by the spatial resolution of our setup. © 2014 Optical Society of America.
Web of Science (2014): Impact factor 3.488
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 4.38 SJR 2.337 SNIP 2.196
Web of Science (2013): Impact factor 3.525
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 3.85 SJR 2.562 SNIP 2.108
Web of Science (2012): Impact factor 3.546
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 4.04 SJR 2.58 SNIP 2.572
Web of Science (2011): Impact factor 3.587
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.906 SNIP 2.428
Web of Science (2010): Impact factor 3.753
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 3.039 SNIP 2.679
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 3.204 SNIP 2.423
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 3.284 SNIP 2.11
Web of Science (2007): Indexed yes
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 3.313 SNIP 2.336
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 2.819 SNIP 2.472
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 2.669 SNIP 2.217
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 1.745 SNIP 1.748
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 1.496 SNIP 1.42
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 0.98 SNIP 0.761
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 1.442 SNIP 0.843

Original language: English
Keywords: Light extinction, Optimization, Three dimensional, Topology, Extinction ratios, Infra-red cameras, Optimized designs, Photonic crystal waveguide, Silicon-on-insulator materials, Spatial resolution, Vertical gratings, Wavelength ranges, Optical waveguides
Electronic versions:
Topoogy_optimized_mode_conversion.pdf
DOIs:
10.1364/OE.22.008525
Source: FindIt
Source-ID: 266781408
Research output: Research - peer-review; Journal article – Annual report year: 2014
Wavelength Conversion of a 9.35-Gb/s RZ OOK Signal in an InP Photonic Crystal Nanocavity

Wavelength conversion of a 10-Gb/s (9.35 Gb/s net rate) return-to-zero ON-OFF keying signal is demonstrated using a simple InP photonic crystal H0 nanocavity with Lorentzian line shape. The shifting of the resonance induced by the generation of free-carriers enables the pump intensity modulation to be transferred to a continuous-wave probe with a sufficiently high quality so that the converted signal can be detected with a conventional telecommunication receiver. A clear eye diagram is observed for the converted signal showing a pre-forward error correction bit-error-ratio down to $10^{-3}$.

General information
State: Published
Organisations: Department of Photonics Engineering, High-Speed Optical Communication, Quantum and Laser Photonics, Nanophotonic Devices
Pages: 257-260
Publication date: 2014
Peer-reviewed: Yes

Publication information
Journal: IEEE Photonics Technology Letters
Volume: 26
Issue number: 3
ISSN (Print): 1041-1135
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 2.84 SJR 0.961 SNIP 1.25
Web of Science (2017): Impact factor 2.446
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.52 SJR 0.989 SNIP 1.224
Web of Science (2016): Impact factor 2.375
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 2.62 SJR 1.19 SNIP 1.266
Web of Science (2015): Impact factor 1.945
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 2.78 SJR 1.421 SNIP 1.583
Web of Science (2014): Impact factor 2.11
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 2.95 SJR 1.495 SNIP 1.548
Web of Science (2013): Impact factor 2.176
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 2.46 SJR 1.647 SNIP 1.694
Web of Science (2012): Impact factor 2.038
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 2.48 SJR 1.539 SNIP 2.04
Wavelength sweepable laser source

Wavelength sweepable laser source is disclosed, wherein the laser source is a semiconductor laser source adapted for generating laser light at a lasing wavelength. The laser source comprises a substrate, a first reflector, and a second reflector. The first and second reflector together defines an optical cavity, and are arranged to support light oscillation in the optical cavity along an optical path in a direction normal to the substrate. The optical cavity comprises a void in the optical path. The second reflector is resiliently suspended by a suspension in a distance from the first reflector and having a rest position, the second reflector and suspension together defining a microelectromechanical MEMS oscillator. The MEMS oscillator has a resonance frequency and is adapted for oscillating the second reflector on either side of the rest position.; The laser source further comprises electrical connections adapted for applying an electric field to the MEMS oscillator. Furthermore, a laser source system and a method of use of the laser source are disclosed.

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices, Quantum and Laser Photonics
Contributors: Yvind, K., Ansbæk, T., Chung, I., Hansen, O.
Publication date: 2014

Publication information
IPC: H01S5/183
1060-nm Tunable Monolithic High Index Contrast Subwavelength Grating VCSEL

We present the first tunable vertical-cavity surface-emitting laser (VCSEL) where the top distributed Bragg reflector has been completely substituted by an air-cladded high-index-contrast subwavelength grating (HCG) mirror. In this way, an extended cavity design can be realized by reducing the reflection at the semiconductor–air interface using an anti-reflective coating (ARC). We demonstrate how the ARC can be integrated in a monolithic structure by oxidizing AlGaAs with high Al-content. The HCG VCSEL has the potential to achieve polarization stable single-mode output with high tuning efficiency. The HCG VCSEL shows a total tuning range of 16 nm around an emission wavelength of 1060 nm with 1-mW output power.
In this paper, we present recent progress in modeling, design, fabrication and experimental characterization of InP photonic crystal all-optical switches. Novel designs with increased flexibility and performance are presented, and their operation using high speed data signals is analyzed numerically.
All-Optical 9.35 Gb/s Wavelength Conversion in an InP Photonic Crystal Nanocavity

Wavelength conversion of a 9.35 Gb/s RZ signal is demonstrated using an InP photonic crystal H0 nanocavity. A clear eye is observed for the converted signal showing a pre-FEC bit error ratio down to 10-3.

Crystallographic dependence of the lateral undercut wet etch rate of Al0.5In0.5P in diluted HCl for III-V sacrificial release

The authors investigated the use of InAlP as a sacrificial layer lattice-matched to GaAs when diluted hydrochloric acid is used for sacrificial etching. They show that InAlP can be used to fabricate submicrometer air gaps in micro-opto-electromechanical systems and that a selectivity toward GaAs larger than 500 is achieved. This selectivity enables fabrication control of the nanometer-size structures required in photonic crystal and high-index contrast subwavelength grating structures. The crystallographic dependence of the lateral etch rate in InAlP is shown to be symmetric around the \(\langle 110\rangle\) directions where an etch rate of 0.5µm/min is obtained at 22°C in HCl:2H2O. Since the etch rate in the \(\langle 100\rangle\) directions exceeds by ten times that of the \(\langle 110\rangle\) directions, InAlP may be used in sacrificial release of high-aspect ratio structures. Free-hanging structures with length to air-gap aspect ratios above 600 are demonstrated by use of critical point drying following the sacrificial etch.
Design and geometry of hybrid white light-emitted diodes for efficient energy transfer from the quantum well to the nanocrystals

We demonstrate light color conversion in patterned InGaN light-emitting diodes (LEDs), which is enhanced via nonradiative exciton resonant energy transfer (RET) from the electrically driven diode to colloidal semiconductor nanocrystals (NCs). Patterning of the diode is essential for the coupling between a quantum well (QW) and NCs, because the distance between the QW and NCs is a main and very critical factor of RET. Moreover, a proper design of the pattern can enhance light extraction.

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices, Department of Physics, Diode Lasers and LED Systems
Contributors: Kopylov, O., Huck, A., Shirazi, R., Yvind, K., Kardynal, B.
Number of pages: 6
Publication date: 2013
Peer-reviewed: Yes

Publication information
Journal: Proceedings of SPIE, the International Society for Optical Engineering
Volume: 8625
Article number: 862524
ISSN (Print): 0277-786X
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 0.43 SJR 0.243 SNIP 0.289
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.42 SJR 0.226 SNIP 0.258
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 0.3 SJR 0.212 SNIP 0.239
BFI (2014): BFI-level 1
Dynamic Characterization and Impulse Response Modeling of Amplitude and Phase Response of Silicon Nanowires

Amplitude and phase dynamics of silicon nanowires were measured using time-resolved spectroscopy. Time shifts of the maximum phase change and minimum amplitude as a function of pump power due to saturation of the free-carrier density were observed. A phenomenological impulse response model used to fit the experimental data indicated that the free-carrier lifetime was between $7.5 \leq \tau_{fc} \leq 16.2\ \text{ns}$, and the two-photon absorption coefficient and the Kerr coefficient were $3 \times 10^{-12}\ \text{m.W}^{-1}$ and $4 \times 10^{-18}\ \text{m}^2.\text{W}^{-1}$, respectively, for silicon nanowires with lengths varying from 3.6 to 14.9 mm.
Electrical injection schemes for nanolasers

The performance of injection schemes among recently demonstrated electrically pumped photonic crystal nanolasers has been investigated numerically. The computation has been carried out at room temperature using a commercial semiconductor simulation software. For the simulations two electrical injection schemes have been compared: vertical p-i-n junction through a current post structure as in1 and lateral p-i-n junction with either uniform material as in2 or with a buried heterostructure (BH) as in3. To allow a direct comparison of the three schemes the same active material composition consisting of 3 InGaAsP QWs on an InP substrate has been chosen for the modeling. In the simulations the main focus is on the electrical and optical properties of the nanolasers i.e. electrical resistance, threshold voltage, threshold current and wallplug efficiency. In the current flow evaluation the lowest threshold current has been achieved with the lateral electrical injection through the BH; while the lowest resistance has been obtained from the current post structure even though this model shows a higher current threshold because of the lack of carrier confinement. Final scope of the simulations is the analyses of advantages and disadvantages of different electrical injection schemes for the development of the optimal device design for the future generation of electrically pumped nanolasers for terabit communication.
Exciton dynamics in near-surface InGaN quantum wells coupled to colloidal nanocrystals

We study non-radiative energy transfer between InGaN quantum wells and colloidal InP nanocrystals separated by sub-10nm distance. A significant non-radiative energy transfer between the two layers is accompanied by reduced surface recombination in InGaN.

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices, Diode Lasers and LED Systems
Contributors: Kopylov, O., Shirazi, R., Yvind, K., Kardynal, B.
Number of pages: 2
Pages: 147-148
Publication date: 2013

Host publication information
Title of host publication: Proceedings of IEEE Photonics Conference (IPC) 2013
Publisher: IEEE
ISBN (Print): 978-1-4577-1506-8
DOIs: 10.1109/IPCon.2013.6656415

Forward error correction supported 150 Gbit/s error-free wavelength conversion based on cross phase modulation in silicon

We build a forward error correction (FEC) module and implement it in an optical signal processing experiment. The experiment consists of two cascaded nonlinear optical signal processes, 160 Gbit/s all optical wavelength conversion based on the cross phase modulation (XPM) in a silicon nanowire and subsequent 160 Gbit/s-to-10 Gbit/s demultiplexing in a highly nonlinear fiber (HNLF). The XPM based all optical wavelength conversion in silicon is achieved by off-center filtering the red shifted sideband on the CW probe. We thoroughly demonstrate and verify that the FEC code operates correctly after the optical signal processing, yielding truly error-free 150 Gbit/s (excl. overhead) optically signal processed data after the two cascaded nonlinear processes. © 2013 Optical Society of America.

General information
State: Published
Organisations: Department of Photonics Engineering, High-Speed Optical Communication, Coding and Visual Communication, Networks Technology and Service Platforms, Nanophotonic Devices
Pages: 3152-3160
Publication date: 2013
Peer-reviewed: Yes

Publication information
Journal: Optics Express
Volume: 21
Issue number: 3
ISSN (Print): 1094-4087
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
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Web of Science (2017): Impact factor 3.356
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Original language: English

Electronic versions:
Photomixer for terahertz electromagnetic wave emission comprising quantum dots in a laser cavity

The present invention relates to a photomixer for generating terahertz electromagnetic radiation in response to illumination by a time-modulated optical signal. The photomixer (300) comprises a carrier substrate (310) with a plurality of quantum dots arranged in an emission region (308) thereof. A laser cavity (not shown) is arranged around the emission region of the carrier substrate (310) and an incident light (303) passage is adapted to directing the time-modulated optical signal to the emission region (308). Stimulated emission via the laser cavity is induced in the emission region (308) such that recombination of trapped electrons and holes in the plurality of quantum dots is accelerated to efficiently deplete the trap states.

Resonant MEMS tunable VCSEL

We demonstrate how resonant excitation of a microelectro-mechanical system can be used to increase the tuning range of a vertical-cavity surface-emitting laser two-fold by enabling both blue- and red-shifting of the wavelength. In this way a short-cavity design enabling wide tuning range can be realized. A high-index-contrast subwavelength grating vertical-cavity surface-emitting laser with a monolithically integrated anti-reflection coating is presented. By incorporating an antireflection coating into the air cavity, higher tuning efficiency can be achieved at low threshold current. The first result shows 24-nm continuous resonant tuning range around an emission wavelength of 1060 nm with 0.9 mW output power.
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Note: SJR = Scopus Journal Rank, SNIP = Source Normalized Impact Parameter
Switching characteristics of an InP photonic crystal nanocavity: Experiment and theory

The dynamical properties of an InP photonic crystal nanocavity are experimentally investigated using pump-probe techniques and compared to simulations based on coupled-mode theory. Excellent agreement between experimental results and simulations is obtained when employing a rate equation model containing three time constants, that we interpret as the effects of fast carrier diffusion from an initially localized carrier distribution and the slower effects of surface recombination and bulk recombination. The variation of the time constants with parameters characterizing the nanocavity structure is investigated. The model is further extended to evaluate the importance of the fast and slow carrier relaxation processes in relation to patterning effects in the device, as exemplified by the case of all-optical wavelength conversion.
Systematic investigation of the temperature behavior of InAs/InP quantum nanostructure passively mode-locked lasers

This paper aims to investigate the effects of the temperature on the mode-locking capability of two section InAs/InP quantum nanostructure (QN) passively mode locked lasers. Devices are made with multi-layers of self-assembled InAs QN either grown on InP(100) (5 quantum dashes (QDashes) layers) or on InP (311)B (6 quantum dots (QDs) layers). Using an analytical model, the mode-locking stability map is extracted for the two types of QN as a function of optical absorption, cavity length, current density and temperature. We believe that this study is of first importance since it reports for the first time a systematic investigation of the temperature-dependence on the mode-locking properties of InAs/InP QN devices. Beside, a rigorous comparison between QDashes and QDs temperature dependence is proposed through a proper analysis of the mode-locking stability maps. Experimental results also show that under some specific conditions the mode-locking operation can be temperature independent.

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices, Universite europeenne de Bretagne
Contributors: Klaime, K., Piron, R., Grillot, F., Dontabactouny, M., Loualiche, S., Le Corre, A., Yvind, K.
Number of pages: 8
Pages: 863407
Publication date: 2013
Peer-reviewed: Yes

Publication information
Journal: Proceedings of SPIE, the International Society for Optical Engineering
Volume: 8634
ISSN (Print): 0277-786X
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 0.43 SJR 0.243 SNIP 0.289
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.42 SJR 0.226 SNIP 0.258
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ISI indexed (2013): ISI indexed no
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 0.27 SJR 0.219 SNIP 0.275
ISI indexed (2012): ISI indexed no
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 0.31 SJR 0.217 SNIP 0.286
ISI indexed (2011): ISI indexed no
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.233 SNIP 0.277
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.236 SNIP 0.312
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.245 SNIP 0.3
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.247 SNIP 0.376
Tailored design of WDM filters in BCB embedded PhC membranes

We propose a design strategy for wavelength division multiplexing (WDM) filters in BCB embedded photonic crystal membranes. Due to the weaker vertical confinement determined by the material embedding the whole structure, accurate tailoring of the resonant cavity and of both bus and drop waveguides is necessary, in order to guarantee the required performance of the filter for WDM applications.

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices, University of Ferrara, Thales
Contributors: Malaguti, S., Bellanca, G., Ottaviano, L., Yvind, K., Combrié, S., Rossi, A. D., Trillo, S.
Pages: 329-342
Publication date: 2013
Peer-reviewed: Yes

Publication information
Journal: Optical and Quantum Electronics
Volume: 45
Issue number: 4
ISSN (Print): 0306-8919
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
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Web of Science (2013): Impact factor 1.078
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
The chromatographic separation of particles using optical electric fields

We introduce a new field-flow fractionation (FFF) technique, whereby molecules are separated based on their differential interaction (dielectrophoresis (DEP)) with optical electric fields, i.e. electric fields with frequencies in the visible and near-infrared range. The results show that a parallel array of axially non-uniform optical fields yielding an attractive potential (positive-DEP-FFF) is advantageous for the separation of polymers, biomolecules, and nanoparticles over very short distances. Furthermore, positive-DEP-FFF yields superior selectivity and resolution compared to conventional separation techniques, which do not lend themselves to miniaturization. A wide range of parameters are considered and the results are presented considering traditional chromatography parameters: the retention ratio and resolution. A simple analytical model is introduced which captures the trends for small normalized decay lengths and will be useful in the design of experimental separation platforms.

General information
State: Published
Organisations: Department of Chemical and Biochemical Engineering, The Danish Polymer Centre, Department of Photonics Engineering, Structured Electromagnetic Materials, Nanophotonic Devices
Contributors: Javier Alvarez, N., Jeppesen, C., Yvind, K., Mortensen, N. A., Hassager, O.
Pages: 928-939
Publication date: 2013
Peer-reviewed: Yes
Topology Optimized Mode Conversion In a Photonic Crystal Waveguide

We experimentally demonstrate an ultra-compact TE0-TE1 mode converter obtained in a photonic crystal waveguide by utilizing topology optimization and show a ~39 nm bandwidth around 1550 nm with an insertion loss lower than ~3 dB.

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices, Solid Mechanics, Department of Mechanical Engineering, High-Speed Optical Communication
Contributors: Frandsen, L. H., Elesin, Y., Ding, Y., Sigmund, O., Yvind, K.
Pages: 333-334
Publication date: 2013

Host publication information
Title of host publication: 2013 IEEE Photonics Conference (IPC)
Publisher: IEEE
ISBN (Print): 978-1-4577-1506-8
Electronic versions:
Topology Optimized Mode Conversion In a Photonic Crystal Waveguide.pdf
DOIs: 10.1109/IPCon.2013.6656572
Source: dtu
Source-ID: u::9110
Research output: Research - peer-review > Article in proceedings – Annual report year: 2013

Tunable Resonant-Cavity-Enhanced Photodetector with Double High-Index-Contrast Grating Mirrors

In this paper, we propose a broadband-tunable resonant-cavity-enhanced photodetector (RCE-PD) structure with double high-index-contrast grating (HCG) mirrors and numerically investigate its characteristics. The detector is designed to operate at 1550-nm wavelength. The detector structure consists of a top InP HCG mirror, a p-i-n photodiode embedding multiple quantum wells, and a Si HCG mirror formed in the Si layer of a silicon-on-insulator wafer. The detection wavelength can be changed by moving the top InP HCG mirror suspended in the air. High reflectivity and small penetration length of HCGs lead to a narrow absorption linewidth of 0.38 nm and a broad tuning range of 111 nm. The peak absorption efficiency is 76-84% within the tuning range. This broadband-tunable and narrow-absorption-linewidth RCE-PD is desirable for applications where selective wavelength demultiplexing is required. Furthermore, the fact that it can be fabricated on a silicon platform offers us a possibility of integration with electronics.

General information
State: Published
Organisations: Department of Photonics Engineering, Quantum and Laser Photonics, Metro-Access and Short Range Systems, Nanophotonic Devices
Contributors: Learkthanakhachon, S., Yvind, K., Chung, I.
Number of pages: 6
Publication date: 2013
Peer-reviewed: Yes

Publication information
Ultra-Fast Low Energy Switching Using an InP Photonic Crystal H0 Nanocavity

Pump-probe measurements on InP photonic crystal H0 nanocavities show large-contrast ultrafast switching at low pulse energy. For large pulse energies, high-frequency carrier density oscillations are induced, leading to pulsesplitting.
Ultrahigh-speed hybrid laser for silicon photonic integrated chips

Increasing power consumption for electrical interconnects between and inside chips is posing a real challenge to continue the performance scaling of processors/computers as predicted by D. Moore. In recent processors, energy consumption for electrical interconnects is half of power supplied and will be 80% in near future. This challenge strongly has motivated replacing electrical interconnects with optical ones even in chip level communications [1]. This chip-level optical interconnects need quite different performance of optoelectronic devices than required for conventional optical communications. For a light source, the energy consumption per sending a bit is required to be <10 fJ/bit for on-chip interconnects and <100 fJ/bit for off-chip interconnects; this is two or three orders of magnitude smaller than the conventional devices. To meet the energy/bit requirement, many innovative laser diode and light-emitting diode (LED) structures have been proposed so far. Our hybrid laser is one of these efforts [2].

The hybrid laser consists of a dielectric reflector, a III-V semiconductor active material, and a high-index-contrast grating (HCG) reflector formed in the silicon layer of a silicon-on-insulator (SOI) wafer. ‘Hybrid’ indicates that a III-V active material is wafer-bonded to a silicon SOI wafer. In the hybrid laser, light is vertically amplified between the dielectric and the HCG reflectors, while the light output is laterally emitted to a normal Si ridge waveguide that is connected to the HCG reflector. The HCG works as a vertical mirror as well as a vertical-to-lateral coupler. Very small field penetration into the HCG allows for 3-4 times smaller modal volume than typical vertical-cavity surface-emitting lasers (VCSELs). This leads to high direct modulation speed. Details on device operating mechanism will be explained in the lecture.

Recently, a nano light-emitting diode (LED) with energy/bit < 1fJ/bit [3] and a nano laser diode with a buried heterostructure (BH) active material [4] have been recently reported in the literature. Additionally, device physics, engineering issue, and error-free light detection issue in quantum limit will be discussed in relation to these two structures.
Ultra-high-speed Optical Signal Processing using Silicon Photonics
— In supercomputers, the optical inter-connects are getting closer and closer to the processing cores. Today, a single supercomputer system has as many optical links as the whole worldwide web together, and it is envisaged that future computing chips will contain multiple electronic processor cores with a photonic layer on top to interconnect them. For such systems, silicon is an attractive candidate enabling both electronic and photonic control. For some network scenarios, it may be beneficial to use optical on-chip packet switching, and for high data-density environments one may take advantage of the ultra-fast nonlinear response of silicon photonic waveguides. These chips offer ultra-broadband wavelength operation, ultra-high timing resolution and ultra-fast response, and when used appropriately offer energy-efficient switching. In this presentation we review some all-optical functionalities based on silicon photonics. In particular we use nano-engineered silicon waveguides (nanowires) [1] enabling efficient phasematched four-wave mixing (FWM), cross-phase modulation (XPM) or self-phase modulation (SPM) for ultra-high-speed optical signal processing of ultra-high bit rate serial data signals. We show that silicon can indeed be used to control Tbit/s serial data signals [2], perform 640 Gbit/s wavelength conversion [3] 640 Gbit/s serial-to-parallel conversion [4], 160 Gbit/s packet switching as well as all-optical regeneration [5]. We will also discuss the performance limitations of crystalline silicon and discuss emerging materials such as amorphous silicon [6].

General information
State: Published
Organisations: Department of Photonics Engineering, High-Speed Optical Communication, Nanophotonic Devices
Number of pages: 1
Publication date: 2013
Peer-reviewed: Yes
Electronic versions:
2013_08_PIERS_Ultra_high_speed_Optical_Signal_Processing_Using_Silicon_Photonics.pdf
Source: PublicationPreSubmission
Source-ID: 107595249
Research output: Research - peer-review » Conference abstract for conference – Annual report year: 2013

Wavelength Selective 3D Topology Optimized Photonic Crystal Devices
A compact photonic crystal drop filter has been designed using 3D topology optimization and fabricated in silicon-on-insulator material. Measurements and modeling are in excellent agreement showing a low-loss ~11nm 3dB bandwidth of the filter.

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices, Solid Mechanics, Department of Mechanical Engineering
Contributors: Frandsen, L. H., Elesin, Y., Sigmund, O., Jensen, J. S., Yvind, K.
Publication date: 2013

Host publication information
Title of host publication: Proceedings of 2013 Conference on Lasers and Electro-Optics (CLEO)
Publisher: IEEE
Article number: CTh4L.6
Keywords: Mathematical methods in physics, Photonic crystal waveguides, Wavelength filtering devices
DOI:
10.1364/CLEO_SI.2013.CTh4L.6
Source: Bibtex
Source-ID: urn:a00f41f75e8c28a15dedfd04cf9dac3b
Research output: Research - peer-review » Article in proceedings – Annual report year: 2014

160 Gbit/s optical packet switching using a silicon chip
We have successfully demonstrated 160 Gbit/s all-optical packet switching based on cross-phase modulation using a silicon chip. Error free performance is achieved for the 4-to-1 switched 160 Gbit/s packet.

General information
State: Published
Organisations: Department of Photonics Engineering, High-Speed Optical Communication, Nanophotonic Devices
Pages: 915-916
Publication date: 2012

Host publication information
160 Gb/s Silicon All-Optical Data Modulator based on Cross Phase Modulation

We have demonstrated 160 Gb/s all-optical data modulation with an extinction ratio of 18.5 dB based on XPM in a silicon nanowire. Error free performance is achieved for the optically modulated 160 Gb/s signal.

General information
State: Published
Organisations: Department of Photonics Engineering, High-Speed Optical Communication, Nanophotonic Devices, Quantum and Laser Photonics
Number of pages: 3
Pages: OM2E.2
Publication date: 2012

Host publication information
Title of host publication: OFC/NFOEC Technical Digest
Publisher: Optical Society of America
Electronic versions: 03BD5d01.pdf

Bibliographical note
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Research output: Research - peer-review + Article in proceedings – Annual report year: 2012

40 Gbit/s serial data signal regeneration using self-phase modulation in a silicon nanowire

We experimentally demonstrate self-phase modulation based all-optical regeneration of a 40 Gbit/s serial data signal in a silicon nanowire. Bit error rate characterization shows 2 dB receiver power improvement.

General information
State: Published
Organisations: Department of Photonics Engineering, High-Speed Optical Communication, Nanophotonic Devices
Pages: 832-833
Publication date: 2012

Host publication information
Title of host publication: 2012 IEEE Photonics Conference (IPC)
Publisher: IEEE
DOIs:
10.1109/IPCon.2012.6359252
Source: dtu
Source-ID: n:oai:DTIC-ART:iel/374655292::22671
Research output: Research - peer-review + Article in proceedings – Annual report year: 2012

41 GHz and 10.6 GHz low threshold and low noise InAs/InP quantum dash two-section mode-locked lasers in L band

This paper reports recent results on InAs/InP quantum dash-based, two-section, passively mode-locked lasers pulsing at 41 GHz and 10.6 GHz and emitting at 1.59 μm at 20 degrees C. The 41-GHz device (1 mm long) starts lasing at 25 mA under uniform injection and the 10.6 GHz (4 mm long) at 71 mA. Their output pulses are significantly chirped. The 41-GHz laser exhibits 7 ps pulses after propagation in 60 m of a single-mode fiber. The 10.6-GHz laser generates one picosecond pulses with 545 m of a single-mode fiber. Its single side-band phase noise does not exceed -80 dBc/Hz at 100 kHz offset, leading to an average timing jitter of 800 fs.
Broadband Nonlinear Signal Processing in Silicon Nanowires

The fast non-linearity of silicon allows Tbit/s optical signal processing. By choosing suitable dimensions of silicon nanowires their dispersion can be tailored to ensure a high nonlinearity at power levels low enough to avoid significant two-photon absorption. We have fabricated low insertion and propagation loss silicon nanowires and use them to demonstrate the broadband capabilities of silicon.
Broadband Polarization-Insensitive Wavelength Conversion Based on Non-Degenerate Four-Wave Mixing in a Silicon Nanowire

We experimentally demonstrate broadband polarization-insensitive one-to-two wavelength conversion of a 10-Gb/s DPSK data signal based on non-degenerate four-wave mixing in a silicon nanowire with bit-error rate measurements.

Comparison of Monolithic Optical Frequency Comb Generators Based on Passively Mode-Locked Lasers for Continuous Wave mm-Wave and Sub-THz Generation

In this paper, two different Passive Mode-Locked Laser Diodes (PMLLD) structures, a Fabry–Perot cavity and a ring cavity laser are characterized and evaluated as monolithic Optical Frequency Comb Generators (OFCG) for CW sub-THz generation. An extensive characterization of the devices under study is carried out based on an automated measurement system that systematically evaluates the dynamic characteristics of the devices, focusing on the figures of merit that define the optimum performance of a pulsed laser source when considered as an OFCG. Sub-THz signals generated with both devices at 60 GHz and 90 GHz are presented and analyzed in terms of electrical linewidth to compare such components for mm-Wave and sub-THz photonic generation. This work offers a systematic comparison of PMLLD devices for OFCG operation and provides reference information of the performance of two different device topologies that can be used for the implementation of photonic integrated sub-THz CW generation.
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.87 SJR 1.23 SNIP 1.819
Web of Science (2016): Impact factor 3.671
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 4.15 SJR 1.598 SNIP 1.901
Web of Science (2015): Impact factor 2.567
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 4.23 SJR 1.737 SNIP 2.411
Web of Science (2014): Impact factor 2.965
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 4.03 SJR 1.622 SNIP 2.439
Web of Science (2013): Impact factor 2.862
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 3.21 SJR 1.888 SNIP 2.491
Web of Science (2012): Impact factor 2.555
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 3.2 SJR 1.733 SNIP 2.957
Web of Science (2011): Impact factor 2.784
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.737 SNIP 2.401
Web of Science (2010): Impact factor 2.259
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 2.096 SNIP 2.749
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 2.198 SNIP 2.443
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 2.313 SNIP 2.212
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 2.03 SNIP 2.562
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 2.846 SNIP 2.952
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 2.332 SNIP 2.688
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 2.703 SNIP 2.876
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 2.751 SNIP 2.588
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 2.999 SNIP 2.112
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 2.379 SNIP 1.821
Web of Science (2000): Indexed yes
Complex characterization of short-pulse propagation through InAs/InP quantum-dash optical amplifiers: From the quasi-linear to the two-photon-dominated regime

We describe direct measurements at a high temporal resolution of the changes experienced by the phase and amplitude of an ultra-short pulse upon propagation through an inhomogenously broadened semiconductor nanostructured optical gain medium. Using a cross frequency-resolved optical gating technique, we analyze 150 fs-wide pulses propagating along an InP based quantum dash optical amplifier in both the quasi-linear and saturated regimes. For very large electrical and optical excitations, a second, trailing peak is generated and enhanced by a unique two-photon-induced amplification process. © 2011 Optical Society of America.
Web of Science (2013): Impact factor 3.525
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 3.85 SJR 2.562 SNIP 2.108
Web of Science (2012): Impact factor 3.546
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 4.04 SJR 2.58 SNIP 2.572
Web of Science (2011): Impact factor 3.587
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.906 SNIP 2.428
Web of Science (2010): Impact factor 3.753
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 3.039 SNIP 2.679
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 3.204 SNIP 2.423
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 3.284 SNIP 2.11
Web of Science (2007): Indexed yes
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 3.313 SNIP 2.336
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 2.819 SNIP 2.472
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 2.669 SNIP 2.217
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 1.745 SNIP 1.748
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 1.496 SNIP 1.42
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 0.98 SNIP 0.761
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 1.442 SNIP 0.843
Original language: English
Electronic versions: 742C7d01.pdf
DOIs: 10.1364/OE.20.000347

**Bibliographical note**

This paper was published in Optics Express and is made available as an electronic reprint with the permission of OSA. The paper can be found at the following URL on the OSA website: http://www.opticsinfobase.org/abstract.cfm?URI=oe-20-1-347. Systematic or multiple reproduction or distribution to multiple locations via electronic or other means is prohibited and is subject to penalties under law.

Source: orbit
Source-ID: 317186

Research output: Research - peer-review ; Journal article – Annual report year: 2012
Dynamic characterization of silicon nanowires using a terahertz optical asymmetric demultiplexer-based pump-probe scheme

Dynamic phase and amplitude all-optical responses of silicon nanowires are characterized using a terahertz optical asymmetric demultiplexer (TOAD) based pump-probe scheme. Ultra-fast recovery is observed for moderate pump powers.

General information
State: Published
Organisations: Department of Photonics Engineering, High-Speed Optical Communication, Nanophotonic Devices, University College Cork
Publication date: 2012

Effect of Asymmetric Barrier Layers in the Waveguide Region on the Temperature Characteristics of QuantumWell Lasers

The temperature sensitivity of the threshold-current density in quantum-well lasers is studied and the factors affecting the characteristic temperature and its dependence on optical losses are analyzed. It is shown that the inclusion of asymmetric potential barriers (one barrier on each side of the quantum well), which prevent the formation of bipolar carrier population in the waveguide region and lead to weakening of the temperature dependences of the transparency-current density, the gain-saturation parameter and, consequently, to a higher characteristic temperature for both long- and short-cavity laser diodes.

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices, St. Petersburg Academic University, Virginia Polytechnic Institute and State University, Russian Academy of Sciences
Pages: 1027-1031
Publication date: 2012
Peer-reviewed: Yes
Enhanced Gain in Photonic Crystal Amplifiers

We experimentally demonstrate enhanced gain in the slow-light regime of quantum well photonic crystal amplifiers. A strong gain enhancement is observed with the increase of the group refractive index, due to light slow-down. The slow light enhancement is shown in a amplified spontaneous emission study of a 1 QW photonic crystal amplifier. Net gain is achieved which enables laser oscillation in photonic crystal micro cavities. The ability to freely tailor the dispersion in a semiconductor optical amplifier makes it possible to raise the optical gain considerably over a certain bandwidth. These results are promising for short and efficient semiconductor optical amplifiers. This effect will also benefit other devices, such as mode locked lasers.

General information

State: Published
Organisations: Department of Photonics Engineering, Quantum and Laser Photonics, Nanophotonic Devices, Nanophotonics
Contributors: Ek, S., Semenova, E., Hansen, P. L., Yvind, K., Mørk, J.
Number of pages: 4
Publication date: 2012
Experimental demonstration of a four-port photonic crystal cross-waveguide structure

We report the design and fabrication of a four-port InP photonic crystal cavity-waveguide structure in which two crossing waveguides intersect in a cavity. Transmission measurements show that by exploiting mode-gap effects, high cross-talk suppression between the two waveguides can be obtained. In addition, the waveguides couple to two distinct cavity resonances with different quality-factors as well as small mode volumes. This structure is promising for realizing ultra-fast, low-energy optical switches or memories.
Extreme nonlinearities in InAs/InP nanowire gain media: the two-photon induced laser

We demonstrate a novel laser oscillation scheme in an InAs / InP wire-like quantum dash gain medium. A short optical pulse excites carriers by two photon absorption which relax to the energy levels providing gain thereby enabling laser oscillations. The nonlinear dynamic interaction is analyzed and quantified using multi-color pump-probe measurements and shows a highly efficient nonlinear two photon excitation process which is larger by more than an order of magnitude compared to common quantum well and bulk gain media. The dynamic response of the nonlinearly induced laser line is...
characterized by spectrally resolved temporal response measurements, while changes incurring upon propagation in the stimulating short pulse itself are characterized by frequency resolved optical gating (FROG).

**General information**

State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices, Technion-Israel Institute of Technology, University of Kassel
Contributors: Capua, A., Kami, O., Eisenstein, G., Reithmaier, J. P., Yvind, K.
Pages: 5987-5992
Publication date: 2012
Peer-reviewed: Yes

**Publication information**

Journal: Optics Express
Volume: 20
Issue number: 6
ISSN (Print): 1094-4087
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.74 SJR 1.519 SNIP 1.567
Web of Science (2017): Impact factor 3.356
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.48 SJR 1.532 SNIP 1.544
Web of Science (2016): Impact factor 3.307
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 3.78 SJR 1.91 SNIP 1.674
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 4.18 SJR 2.313 SNIP 2.124
Web of Science (2014): Impact factor 3.488
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 4.38 SJR 2.337 SNIP 2.196
Web of Science (2013): Impact factor 3.525
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 3.85 SJR 2.562 SNIP 2.108
Web of Science (2012): Impact factor 3.546
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 4.04 SJR 2.58 SNIP 2.572
Web of Science (2011): Impact factor 3.587
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.906 SNIP 2.428
Web of Science (2010): Impact factor 3.753
Web of Science (2010): Indexed yes
High-speed photodetectors in a photonic crystal platform

We demonstrate a fast photodetector ($f_{3dB} > 40\,\text{GHz}$) integrated into a high-index contrast photonic crystal platform. Device design, fabrication and characterization are presented.

**General information**

State: Published

Organisations: Department of Photonics Engineering, Nanophotonic Devices, Nanophotonics, Universite europeenne de Bretagne, University of Ferrara


Number of pages: 2

Publication date: 2012

**Host publication information**

Title of host publication: CLEO Technical Digest

Publisher: Optical Society of America

Electronic versions:

BEB6Fd01.pdf

High-speed photodetectors in a photonic crystal platform.pdf

**Bibliographical note**

This paper was published in Optics Express and is made available as an electronic reprint with the permission of OSA. The paper can be found at the following URL on the OSA website: http://www.opticsinfobase.org/oe/abstract.cfm?URI=oe-20-6-5987. Systematic or multiple reproduction or distribution to multiple locations via electronic or other means is prohibited and is subject to penalties under law.

Source: dtu

Source-ID: n:oai:DTIC-ART:inspec/363817577::16961

Research output: Research - peer-review ; Journal article – Annual report year: 2012
Improvement of temperature-stability in a quantum well laser with asymmetric barrier layers

We fabricated and tested a quantum well laser with asymmetric barrier layers. Such a laser has been proposed earlier to suppress bipolar carrier population in the optical confinement layer and thus to improve temperature-stability of the threshold current. As compared to the conventional reference laser structure, our laser with asymmetric barrier layers demonstrates reduced internal optical loss, lower threshold current density at elevated temperatures, and higher characteristic temperature (143 vs. 99K at 20 degrees C).
Individual optimization of InAlGaAsP-InP sections for 1.55-μm passively mode-locked lasers

We present integrated single QW semiconductor optical amplifier and MQW electroabsorber modulator based on InAlGaAsP-InP materials for application in a monolithic mode-locked laser. Optimized structures with high-quality butt-joint interfaces are demonstrated.

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices, Nanophotonics
Contributors: Kulkova, I., Larsson, D., Semenova, E., Yvind, K.
InGaAsP photonic crystal nanocavities with a Fano line shape resonant at 1.55 μm
We fabricated and characterized InGaAsP photonic crystal nanocavities. By carefully tailoring the structural parameters, both an efficient coupling and a suitable Q-factor can be achieved. Depending on the design of the coupling region, sharp Fano lines may be observed.

Integrated Photonics Enabled by Slow Light
In this talk we will discuss the physics of slow light in semiconductor materials and in particular the possibilities offered for integrated photonics. This includes ultra-compact slow light enabled optical amplifiers, lasers and pulse sources.

Light modulation abilities of nanostructures
In the work we consider two new routes to impose control on the optical waveguides propagation. The first approach is based on the Kerr effect caused by the THz field, which strength is manifold times enhanced by the presence of a nano...
in a metallic film surrounding the waveguide. The second approach utilizes the gain-core effect on plasmonics modes in metal-semiconductor-metal structures. Our simulations prove that it is quite reasonable to realize both control schemes experimentally.

**General information**
State: Published
Organisations: Department of Photonics Engineering, Metamaterials, Terahertz Technologies and Biophotonics, Nanophotonic Devices
Contributors: Lavrinenko, A., Babicheva, V., Novitsky, A., Zalkovskij, M., Malureanu, R., Jepsen, P. U., Kulkova, I., Yvind, K.
Pages: 25-27
Publication date: 2012

**Host publication information**
Title of host publication: AIP Conference Proceedings
Volume: 1475
Publisher: American Institute of Physics
ISBN (Print): 978-0-7354-1084-8
DOIs: 10.1063/1.4750084

**Bibliographical note**
Invited presentation.
Source: dtu
Source-ID: n::oai:DTIC-ART:inspec/369630691::19371
Research output: Research - peer-review › Conference abstract in proceedings – Annual report year: 2012

**Nano-selective area growth of InGaAs/InP using CBr4 insitu etching**
We are investigating the conditions for nano-patterned selective area epitaxial growth using e-beam lithography on HSQ resist and in-situ etching in the MOVPE reactor.

**General information**
State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices, Center for Electron Nanoscopy, Nanophotonics
Contributors: Kuznetsova, N., Semenova, E., Kadkhodazadeh, S., Schubert, M., Yvind, K.
Number of pages: 3
Pages: JTu5A.12
Publication date: 2012

**Host publication information**
Title of host publication: Advanced Photonics Congress
Publisher: Optical Society of America
Source: dtu
Source-ID: u::7046
Research output: Research - peer-review › Article in proceedings – Annual report year: 2012

**Nonlinear carrier dynamics in a quantum dash optical amplifier**
Results of experimental pump-probe spectroscopy of a quantum dash optical amplifier biased at transparency are presented. Using strong pump pulses we observe a competition between free carrier absorption and two-photon induced stimulated emission that can have drastic effects on the transmission dynamics. Thus, both enhancement as well as suppression of the transmission can be observed even when the amplifier is biased at transparency. A simple theoretical model taking into account two-photon absorption and free carrier absorption is presented that shows good agreement with the measurements.

**General information**
State: Published
Organisations: Quantum and Laser Photonics, Department of Photonics Engineering, Nanophotonic Devices, FOTON
Contributors: Hansen, P. L., Ek, S., Yvind, K., Piron, R., Mørk, J.
Pages: 013042
Publication date: 2012
Peer-reviewed: Yes
Observation of phase noise reduction in photonically synthesized sub-THz signals using a passively mode-locked laser diode and highly selective optical filtering

A Continuous Wave (CW) sub-THz photonic synthesis setup based on a single Passively Mode-Locked Laser Diode (PMLLD) acting as a monolithic Optical Frequency Comb Generator (OFCG) and highly selective optical filtering has been implemented to evaluate the phase noise performance of the generated sub-THz signals. The analysis of the synthesized sub-THz signals up to 120 GHz gives as a result an effective reduction of the electrical linewidth when compared to direct harmonic generation that begins at 50 GHz and becomes greater as the frequency increases. The phase noise reduction offered by the setup, along with its integration potential, cost and bandwidth, make it a promising candidate to the development of an integrated and high performance low phase noise local oscillator in the sub-THz range.

General information
State: Published
Organisations: Nanophotonic Devices, Department of Photonics Engineering, Universidad Carlos III de Madrid
Contributors: Criado, A. R., Acedo, P., Carpintero, G., De Dios, C., Yvind, K.
Pages: 1253-1260
Publication date: 2012
Peer-reviewed: Yes

Publication information
Journal: Optics Express
Volume: 20
Issue number: 2
ISSN (Print): 1094-4087
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.74 SJR 1.519 SNIP 1.567
Web of Science (2017): Impact factor 3.356
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.48 SJR 1.532 SNIP 1.544
Web of Science (2016): Impact factor 3.307
Photonic synthesis of continuous-wave millimeter-wave signals using a passively mode-locked laser diode and selective optical filtering

We report a photonic synthesis scheme for continuous wave millimeter-wave signal generation using a single passively mode-locked laser diode (PMLLD), optical filtering and photomixing in a fast photodiode. The phase noise of the photonicely synthesized signals is evaluated and inherits the characteristics of the PMLLD electrical power spectrum.

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices, Nanophotonics, Universidad Carlos III de Madrid
Contributors: Acedo, P., Carpintero, G., Criado, A., de Dios, C., Yvind, K.
Pages: 1416-1419
Publication date: 2012
Peer-reviewed: Yes

Publication information
Journal: Microwave & Optical Technology Letters
Volume: 54
Issue number: 6
ISSN (Print): 0895-2477
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 0.99 SJR 0.273 SNIP 0.599
Web of Science (2017): Impact factor 0.948
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.87 SJR 0.278 SNIP 0.561
Web of Science (2016): Impact factor 0.731
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 0.72 SJR 0.318 SNIP 0.506
Web of Science (2015): Impact factor 0.545
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 0.71 SJR 0.347 SNIP 0.578
Web of Science (2014): Impact factor 0.568
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 0.75 SJR 0.34 SNIP 0.63
Web of Science (2013): Impact factor 0.623
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Physics and applications of slow and fast light in semiconductor optical waveguides

We review the physics of slow and fast light based on coherent population oscillations in active semiconductor waveguides. Exploiting these effects, microwave phase shifters realizing 360 degree phase shift and operating at tens of GHz have been realized.

General information
State: Published
Organisations: Department of Photonics Engineering, Quantum and Laser Photonics, Nanophotonic Devices
Contributors: Mørk, J., Chen, Y., Ek, S., Pu, M., Yvind, K.
Number of pages: 1
Publication date: 2012
Peer-reviewed: Yes
Plasmonic modulator based on finite-thickness metal-semiconductormetal waveguide with gain core

General information
State: Published
Organisations: Department of Photonics Engineering, Metamaterials, Nanophotonic Devices
Contributors: Babicheva, V., Kulkova, I., Malureanu, R., Yvind, K., Lavrinenko, A.
Number of pages: 1
Publication date: 2012
Peer-reviewed: Yes
Electronic versions:
DOPSS.pdf
Source: dtu
Source-ID: u::5571
Research output: Research - peer-review › Paper – Annual report year: 2012

Plasmonic modulator based on gain-assisted metal-semiconductor-metal waveguide

We investigate plasmonic modulators with a gain material to be implemented as ultra-compact and ultra-fast active nanodevices in photonic integrated circuits. We analyze metal-semiconductor-metal (MSM) waveguides with InGaAsP-based active material layers as ultra-compact plasmonic modulators. The modulation is achieved by changing the gain of the core that results in different transmittance through the waveguides. A MSM waveguide enables high field localization and therefore high modulation speed. Bulk semiconductor, quantum wells and quantum dots, arranged in either horizontal or vertical layout, are considered as the core of the MSM waveguide. Dependences on the waveguide core size and gain values of various active materials are studied. The designs consider also practical aspects like n- and p-doped layers and barriers in order to obtain results as close to reality. The effective propagation constants in the MSM waveguides are calculated numerically. Their changes in the switching process are considered as a figure of merit. We show that a MSM waveguide with electrical current control of the gain incorporates compactness and deep modulation along with a reasonable level of transmittance.

General information
State: Published
Organisations: Department of Photonics Engineering, Metamaterials, Nanophotonic Devices
Contributors: Babicheva, V. E., Kulkova, I. V., Malureanu, R., Yvind, K., Lavrinenko, A. V.
Pages: 389-399
Publication date: 2012
Peer-reviewed: Yes

Publication information
Journal: Photonics and Nanostructures - Fundamentals and Applications
Volume: 10
Issue number: 4
ISSN (Print): 1569-4410
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 1.63 SJR 0.433 SNIP 0.762
Web of Science (2017): Impact factor 1.575
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.8 SJR 0.535 SNIP 0.823
Web of Science (2016): Impact factor 1.705
BFI (2015): BFI-level 1
Polarization Insensitive One-to-Six WDM Multicasting in a Silicon Nanowire

We present polarization insensitive one-to-six WDM multicasting based on nondegenerate four-wave mixing in a silicon nanowire with angled-pump scheme. Bit-error rate measurements are performed and error-free operation is achieved.

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices, High-Speed Optical Communication, Quantum and Laser Photonics
Number of pages: 3
Polarization Inensitive Wavelength Conversion Based on Four-Wave Mixing in a Silicon Nanowire

We experimentally demonstrate, for the first time, polarization-insensitive wavelength conversion of a 10 Gb/s NRZ-OOK data signal based on four-wave mixing in a silicon nanowire with bit-error rate measurements.

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices, High-Speed Optical Communication, Quantum and Laser Photonics
Number of pages: 3
Pages: IW4C.4
Publication date: 2012

Polarization insensitive wavelength conversion in a dispersion-engineered silicon waveguide

We experimentally demonstrate polarization-insensitive all optical wavelength conversion of a 10-Gb/s DPSK data signal based on four-wave mixing in a silicon waveguide with an angled-pump scheme. Dispersion engineering is applied to the silicon waveguide to obtain similar four-wave mixing conversion performances for both the TE and TM modes. Bit-error rate measurements are performed and error-free operation is achieved. We also demonstrate polarization-insensitive wavelength conversion with a large separation between the idler and signal using a dual-pump configuration.

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices, High-Speed Optical Communication, Quantum and Laser Photonics
Pages: 16374-16380
Publication date: 2012
Peer-reviewed: Yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.74 SJR 1.519 SNIP 1.567
Web of Science (2017): Impact factor 3.356
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.48 SJR 1.532 SNIP 1.544
Web of Science (2016): Impact factor 3.307
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 3.78 SJR 1.91 SNIP 1.674
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 4.18 SJR 2.313 SNIP 2.124
Web of Science (2014): Impact factor 3.488
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 4.38 SJR 2.337 SNIP 2.196
Web of Science (2013): Impact factor 3.525
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 3.85 SJR 2.562 SNIP 2.108
Web of Science (2012): Impact factor 3.546
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 4.04 SJR 2.58 SNIP 2.572
Web of Science (2011): Impact factor 3.587
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.906 SNIP 2.428
Web of Science (2010): Impact factor 3.753
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 3.039 SNIP 2.679
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 3.204 SNIP 2.423
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 3.284 SNIP 2.11
Web of Science (2007): Indexed yes
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 3.313 SNIP 2.336
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 2.819 SNIP 2.472
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 2.669 SNIP 2.217
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 1.745 SNIP 1.748
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 1.496 SNIP 1.42
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 0.98 SNIP 0.761
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 1.442 SNIP 0.843
Original language: English
Electronic versions:
1525Ad01.pdf
DOIs:
10.1364/OE.20.016374

Bibliographical note
This paper was published in Optics Express and is made available as an electronic reprint with the permission of OSA. The paper can be found at the following URL on the OSA website: http://www.opticsinfobase.org/oe/abstract.cfm?uri=oe-20-15-16374. Systematic or multiple reproduction or distribution to multiple locations via electronic or other means is prohibited and is subject to penalties under law.

Research output: Research - peer-review › Journal article – Annual report year: 2012

Silicon Nanowires for All-Optical Signal Processing in Optical Communication

Silicon (Si), the second most abundant element on earth, has dominated in microelectronics for many decades. It can also be used for photonic devices due to its transparency in the range of optical telecom wavelengths which will enable a platform for a monolithic integration of optics and microelectronics. Silicon photonic nanowire waveguides fabricated on silicon-on-insulator (SOI) substrates are crucial elements in nano-photonic integrated circuits. The strong light confinement in nanowires induced by high index contrast SOI material enhances the nonlinear effects in the silicon nanowire core such as four-wave mixing (FWM) which is an imperative process for optical signal processing. Since the current mature silicon fabrication technology enables a precise dimension control on nanowires, dispersion engineering can be performed by tailoring nanowire dimensions to realize an efficient nonlinear process. In the last four years, we investigated and demonstrated different ultra-fast all-optical nonlinear signal processing applications in silicon nanowires for optical time domain multiplexing (OTDM) systems, including wavelength conversion, signal regeneration, ultra-fast waveform sampling, demultiplexing, and multicasting, which shows great potentials in the future optical communication systems. Although the strong light confinement in nanowires allows efficient nonlinear optical signal processing, it also leads to coupling difficulty between on-chip sub-micron nanowires and micro-size fibers due to the large mode mismatch and index mismatch. Both end-coupling and grating-coupling solution utilizing nano-structures were demonstrated with optimized coupling efficiencies, which make the silicon on-chip nanowire devices more practical for real optical communication systems.

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices, High-Speed Optical Communication
Contributors: Pu, M., Hu, H., Ji, H., Galili, M., Oxenløwe, L. K., Yvind, K.
Number of pages: 1
Publication date: 2012

Host publication information
Title of host publication: Nano-S&T 2012
Electronic versions:
2012_11_Nano-S&T2012_Si nanowires for all-optical signal processing in optical communication.pdf
Source: dtu
Source-ID: u::5461
Research output: Research - peer-review › Conference abstract in proceedings – Annual report year: 2012

Silicon Photonics for Signal Processing of Tbit/s Serial Data Signals

In this paper, we describe our recent work on signal processing of terabit per second optical serial data signals using pure silicon waveguides. We employ nonlinear optical signal processing in nanoengineered silicon waveguides to perform demultiplexing and optical waveform sampling of 1.28-Tbit/s data signals as well as wavelength conversion of up to 320-Gbit/s data signals. We demonstrate that the silicon waveguides are equally useful for amplitude and phase-modulated data signals.

General information
State: Published
Organisations: High-Speed Optical Communication, Department of Photonics Engineering, Nanophotonic Devices, Quantum and Laser Photonics
Slow-light enhancement of spontaneous emission in active photonic crystal waveguides
Photonic crystal defect waveguides with embedded active layers containing single or multiple quantum wells or quantum dots have been fabricated. Spontaneous emission spectra are enhanced close to the bandedge, consistently with the enhancement of gain by slow light effects. These are promising results for future compact devices for terabit/s communication, such as miniaturised semiconductor optical amplifiers and mode-locked lasers.

General information
State: Published
Organisations: Department of Photonics Engineering, Quantum and Laser Photonics, Nanophotonic Devices
Contributors: Ek, S., Chen, Y., Semenova, E., Hansen, P. L., Yvind, K., Mark, J.
Pages: 82731A
Publication date: 2012
Peer-reviewed: Yes

Publication information
Journal: Proceedings of SPIE--the international society for optical engineering
Volume: 8273
Issue number: 1
ISSN (Print): 0277-786X
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 0.43 SJR 0.243 SNIP 0.289
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.42 SJR 0.226 SNIP 0.258
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 0.3 SJR 0.212 SNIP 0.239
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 0.3 SJR 0.217 SNIP 0.249
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 0.26 SJR 0.234 SNIP 0.273
The Chromatographic Separation of Molecules/Particles Using Optical Electric Fields

General information
State: Published
Organisations: Department of Chemical and Biochemical Engineering, The Danish Polymer Centre, Department of Photonics Engineering, Structured Electromagnetic Materials, Nanophotonic Devices
Contributors: Javier Alvarez, N., Jeppesen, C., Yvind, K., Teraoka, I., Mortensen, N. A., Hassager, O.
Publication date: 2012
Peer-reviewed: Yes
Electronic versions:
Optical_Field_Chromatography.pdf

The continuous separation of molecules on the basis of their polarizability using optical electric fields
We introduce a new and revolutionary way to separate macromolecules. The principle is to use light to selectively retain some molecules over others depending on their differential interaction with optical fields. We call the method Photonic Waveguide Chromatography (PWC), as it combines photonic waveguides and a flow channel that constitutes a “column” of conventional liquid chromatography. This presentation will focus on the underlying physics and our current theoretical efforts to characterize the parameter space of this process: considering both the design of the optical electric fields and the fluid dynamics needed to effectively separate molecules. This new method has a higher selectivity than traditional techniques and avoids the problem of fouling. The theoretical separation efficiency and resolution of PWC will be compared to other chromatographic techniques for various macromolecular and biological systems.
Two-Copy Wavelength Conversion of an 80 Gbit/s Serial Data Signal Using Cross-Phase Modulation in a Silicon Nanowire and Detailed Pump-Probe Characterisation

We experimentally demonstrate 80 Gbit/s wavelength conversion to two copies by simultaneously extracting the blue- and red-shifted sidebands from XPM in a silicon nanowire. Bit error rates of 10-9 with only ~2 dB power penalty is achieved for both sidebands. Detailed pump-probe characterisation reveals amplitude and phase responses.

Ultrafast Nonlinear Signal Processing in Silicon Waveguides

We describe recent demonstrations of exploiting highly nonlinear silicon waveguides for ultrafast optical signal processing. We describe wavelength conversion and serial-to-parallel conversion of 640 Gbit/s data signals and 1.28 Tbit/s demultiplexing and all-optical sampling.
Vertical-cavity surface-emitting laser vapor sensor using swelling polymer reflection modulation

Vapor detection using a low-refractive index polymer for reflection modulation of the top mirror in a vertical-cavity surface-emitting laser (VCSEL) is demonstrated. The VCSEL sensor concept presents a simple method to detect the response of a sensor polymer in the presence of volatile organic compounds. We model the physics as a change in the top mirror loss caused by swelling of the polymer upon absorbing the target volatile organic compound. Further we show how acetone vapors at 82 000 ppm concentration can change the polymer coated VCSEL output power by 20 μW.
Wavelength Conversion with Large Signal-Idler Separation using Discrete Four-Wave Mixing in a Silicon Nanowire

We have demonstrated wavelength conversion over 468 nm based on discrete bands phase matching in a silicon nanowire. CW light is converted from 1258 nm to 1726 nm with a CW pump at 1455 nm.

Original language: English

Electronic versions:
CC8A0d01.pdf
DOIs:
10.1063/1.4754291

Bibliographical note
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Source: dtu
Source-ID: n:oai:DTIC-ART:isi/373730006::20951
Research output: Research - peer-review › Journal article – Annual report year: 2012

Wavelength Conversion with Large Signal-Idler Separation using Discrete Four-Wave Mixing in a Silicon Nanowire

We have demonstrated wavelength conversion over 468 nm based on discrete bands phase matching in a silicon nanowire. CW light is converted from 1258 nm to 1726 nm with a CW pump at 1455 nm.

General information
High Capacity Radio over Fiber Transmission Links
This thesis expands the state-of-the-art on the detection of high speed wireless signals using optics. Signal detection at speeds over 1 Gbps at carrier Radio Frequency (RF) ranging from 5 GHz to 100 GHz have been achieved by applying novel concepts on optical digital coherent receivers. This achievement has satisfied the requirements on transmission robustness and high capacity of next generation hybrid optical fibre-wireless networks. One important contribution of this thesis is the novel concept of photonic downconversion with free-running pulsed laser source for phase modulated Radio-over-Fiber (RoF) links. This scheme operates without high frequency electronics at the digital coherent receiver for the detection of high bitrate wireless signals. Based on this concept, I have experimentally demonstrated the recovery of up to 3.2 Gbps 16-QAM signal modulated at 40 GHz RF carrier. At that time, it was the highest bitrate reported of a wireless signal, with complex modulation format, detected using photonic means. I have developed an analytical model to support the experimental results and performed a linearity characterization to establish engineering design rules for this type of links. The results confirmed that this configuration provides high linear end-to-end transmission links and is capable of transparent transport of high spectral efficient modulation formats. Furthermore, this thesis introduces a novel approach for the generation and detection of high speed wireless signals in mm-wave frequencies at carrier frequencies exceeding 60 GHz, using photonic baseband technologies. For signal generation, high spectral-efficient optical modulation technologies are used together with optical heterodyning. In the detection side, the mm-wave signal is modulated in the optical domain and received using digital coherent detection. The experimental demonstration tested the generation and detection in the 60 GHz and 75-110 GHz bands of signals with capacity up to 40 Gbps. Those results reported the highest bitrate at mm-wave frequencies for signal generation and detection using photonic methods at the time of the writing of this thesis. In conclusion, the results presented in this thesis demonstrate the feasibility of photonic technologies for the generation, distribution and detection of high speed wireless signals. Furthermore, it opens the prospects for next generation hybrid wireless-wired access networks providing ultra-high capacities.

Integrated Ultrasonic-Photonic Devices
This thesis deals with the modeling, design, fabrication and characterization of integrated ultrasonic-photonic devices, with particular focus on the use of standard semiconductor materials such as GaAs and silicon. The devices are based on the use of guided acoustic waves to modulate the light in channel waveguides and Mach-Zehnder interferometers. Numerical models are developed based on the finite element method, and applied to several scenarios, such as optimization of the geometrical parameters of waveguides, use of slow light in photonic crystal waveguides and use of Lamb waves in
membrane systems, all in search for paths to improve acousto-optic interaction. Some of the solutions proposed lead to enhancements of up to two orders of magnitude in the efficiency of the device. The main aspects related to the design of the devices are discussed, including single-mode guidance, optical coupling to the fiber, bending losses, power splitting, phase delays and coupling between adjacent waveguides. The use of different numerical methods for the design of the different components are also discussed in terms of accuracy and speed. The devices are fabricated and characterized. Three material platforms were investigated. Comparisons are made with the numerical and experimental results, and they validate the obtained response of the acoustic and photonic components of the device. Finally, a new design for an optical frequency shifter is proposed, posing several advantages over existing devices in terms of size, integration and cost. The design proves to be robust towards fabrication and design tolerances. Several uses for this device are proposed, opening up a whole new group of applications for this class of integrated ultrasonic-photonic devices.

General information
State: Published
Organisations: Department of Photonics Engineering, Quantum and Laser Photonics, Nanophotonic Devices
Contributors: Barretto, E. C. S., Hvam, J. M., Yvind, K., Poel, M. V. D.
Number of pages: 156
Publication date: Jun 2011

Publication information
Place of publication: Kgs. Lyngby, Denmark
Publisher: Technical University of Denmark (DTU)
ISBN (Print): 87-92062-69-5
Original language: English
Electronic versions:
thesis_ecsb_main.pdf
Source: orbit
Source-ID: 312669
Research output: Research › Ph.D. thesis – Annual report year: 2011

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 interfacing silicon ridge waveguides and optical fibers is introduced and insertion losses of less than 1 dB are achieved for both transverse-electric (TE) and transverse-magnetic (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 first time. Microwave phase shifters and notch filters 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 filter 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 different 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
State: Published
Organisations: Nanophotonic Devices, Department of Photonics Engineering, Quantum and Laser Photonics
Contributors: Pu, M., Hvam, J. M., Yvind, K., Ou, H.
Number of pages: 155
Publication date: Apr 2011

Publication information
Place of publication: Kgs. Lyngby, Denmark
Publisher: Technical University of Denmark (DTU)
ISBN (Print): 87-92062-60-1
Original language: English
Electronic versions:
Thesis_lite.pdf
Source: orbit
Source-ID: 271144
Research output: Research › Ph.D. thesis – Annual report year: 2011
Coupled Photonic Crystal Cavity Array Laser
This thesis describes the design, fabrication and characterization of photonic crystal slab lasers. The main focus is on coupled photonic crystal cavity lasers which are examined in great detail. The cavity type which is mainly explored consists of a defect formed by a single missing hole in the quadratic lattice. Processing techniques are developed and optimized in order to fabricate photonic crystals membranes in gallium arsenide with quantum dots as gain medium and in indium gallium arsenide phosphide with quantum wells as gain medium. Several key issues in process to ensure good quality are identified such as the size and material for the carrier wafer in the III-V etch and the importance of removing all remains of the e-beam lithography mask after the etch of the hard mask. Detailed simulations are shown for a simple system with two coupled cavities in different coupling directions. The results are in good agreement with standard coupled mode theory. Also a novel type of photonic crystal structure is proposed called lambda shifted cavity which is a twodimensional photonic crystal laser analog of a VCSEL laser. Detailed measurements of the coupled modes in the photonic crystals with quantum dots are carried out. In agreement with a simple gain model the structures do not show stimulated emission. The spectral splitting due to the coupling between single cavities as well as arrays of cavities is studied theoretically and experimentally. Lasing is observed for photonic crystal cavity structures with quantum wells. A detailed Analysis is conducted on single cavities, two coupled cavities and arrays of coupled cavities. The lasing threshold is determined by measuring the photoluminescence intensity depending on the excitation power. Changes in the linewidth and peak position for different powers confirm the results. While large arrays of coupled cavities exhibit lasing at a single frequency, multimode lasing is demonstrated in structures with only a few coupled cavities. Moreover, lasing is also observed in the lambda shifted cavities. Simulations are shown to determine the theoretical Q factors and mode volumes of these novel structures.

General information
State: Published
Organisations: Nanophotonic Devices, Department of Photonics Engineering, Quantum and Laser Photonics
Contributors: Schubert, M., Yvind, K., Hvam, J. M., Frandsen, L. H.
Number of pages: 169
Publication date: Jan 2011

Publication information
Place of publication: Kgs. Lyngby, Denmark
Publisher: Technical University of Denmark (DTU)
Original language: English
Electronic versions:
Thesis print final.pdf
Source: orbit
Source-ID: 268657
Research output: Research › Ph.D. thesis – Annual report year: 2011

15-THz Tunable Wavelength Conversion of Picosecond Pulses in a Silicon Waveguide
We demonstrate all-optical ultra-broadband tunable wavelength conversion of 1-ps pulses based on four-wave mixing in a 3-mm-long dispersion engineered silicon waveguide. In the waveguide, an input pulse with center wavelength at 1600 nm is down-converted by 135 nm (17.3 THz) to 1465 nm. A tuning range of 115 nm (15 THz, from 1465 to 1580 nm) of the converted wavelength is demonstrated, while keeping conversion efficiency, pulse shape, and pulsewidth almost unchanged.

General information
State: Published
Organisations: Nanophotonic Devices, Department of Photonics Engineering, High-Speed Optical Communication, Quantum and Laser Photonics
Pages: 1409-1411
Publication date: 2011
Peer-reviewed: Yes

Publication information
Journal: I E E E Photonics Technology Letters
Volume: 23
Issue number: 19
ISSN (Print): 1041-1135
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 2.84 SJR 0.961 SNIP 1.25
Web of Science (2017): Impact factor 2.446
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.52 SJR 0.989 SNIP 1.224
Web of Science (2016): Impact factor 2.375
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 2.62 SJR 1.19 SNIP 1.266
Web of Science (2015): Impact factor 1.945
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 2.78 SJR 1.421 SNIP 1.583
Web of Science (2014): Impact factor 2.11
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 2.95 SJR 1.495 SNIP 1.548
Web of Science (2013): Impact factor 2.176
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 2.46 SJR 1.647 SNIP 1.694
Web of Science (2012): Impact factor 2.038
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 2.48 SJR 1.539 SNIP 2.04
Web of Science (2011): Impact factor 2.191
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.457 SNIP 1.678
Web of Science (2010): Impact factor 1.989
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.721 SNIP 1.913
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.975 SNIP 1.864
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 2.224 SNIP 1.678
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 2.012 SNIP 1.869
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 2.882 SNIP 2.411
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 3.092 SNIP 2.689
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 3.17 SNIP 2.436
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 2.97 SNIP 2.1
Web of Science (2002): Indexed yes
320 Gb/s Phase-Transparent Wavelength Conversion in a Silicon Nanowire

All-optical wavelength conversion for a 320-Gb/s RZ-DPSK signal is demonstrated based on four-wave mixing in a silicon nanowire. BER better than 10^-9 is achieved for the wavelength converted RZ-DPSK signal.

Active III-V Semiconductor Photonic Crystal Waveguides

We experimentally demonstrate enhanced amplified spontaneous emission in a quantum well III-V semiconductor photonic crystal waveguide slab. The effect is described by enhanced light matter interaction with the decrease of the group velocity. These are promising results for future compact devices for terabit/s communication, such as miniaturised semiconductor optical amplifiers and mode-locked lasers.
All-Optical Wavelength Conversion of a High-Speed RZ-OOK Signal in a Silicon Nanowire

All-optical wavelength conversion of a 320 Gb/s line-rate RZ-OOK signal is demonstrated based on four-wave mixing in a 3.6 mm long silicon nanowire. Bit error rate measurements validate the performance within FEC limits.

Comparison of the noise performance of 10 GHz repetition rate quantum-dot and quantum well monolithic mode-locked semiconductor lasers

Mode-locked lasers are commonly used in carrier-wave signal generation systems because of their excellent phase noise performance. Owing to the importance of this key parameter, this study presents a like-for-like comparison of the noise performance of the passive mode-locked regime of two devices fabricated with different material gain systems, one quantum well and the other quantum dot (QD), both with a monolithic all-active two-section mode-locked structure. Two important factors are identified as having a significant effect on the noise performance, the RF linewidth of the first harmonic and the shape of the noise pedestals, both depending on the passive mode-locked bias conditions. Nevertheless, the dominant contribution of the RF linewidth to the phase noise, which is significantly narrower for the QD laser, makes this material more suitable for optical generation of low-noise millimetre-wave carrier frequencies.
Complex-coefficient microwave photonic tunable filter using slow light silicon-on-insulator-based microring resonator
Efficient and compact TE-TM polarization converter built on silicon-on-insulator platform with a simple fabrication process

An efficient TE-TM polarization converter built on a silicon-on-insulator nanophotonic platform is demonstrated. The strong cross-polarization coupling effect in air-cladded photonic-wire waveguides is employed to realize the conversion. A peak TE-TM coupling efficiency of 87% (-0.6 dB insertion loss) is measured experimentally. A polarization conversion efficiency of >92% with an overall insertion loss of -1.6 dB is obtained in a wavelength range of 40 nm. The proposed device is compact, with a total length of 44 μm and can be fabricated with one lithography and etching step. © 2011 Optical Society of America.
We experimentally demonstrate enhanced gain in the slow-light regime of quantum dot photonic crystal waveguide slabs. These are promising results for future compact devices for terabit/s communication, such as compact optical amplifiers and mode-locked lasers.

Enhanced Gain in Slow-Light Photonic Crystal Waveguides with Embedded Quantum Dots

We experimentally demonstrate enhanced gain in the slow-light regime of quantum dot photonic crystal waveguide slabs. These are promising results for future compact devices for terabit/s communication, such as compact optical amplifiers and mode-locked lasers.

General information
State: Published
Organisations: Quantum and Laser Photonics, Department of Photonics Engineering, Nanophotonic Devices
Contributors: Ek, S., Hansen, P. L., Semenova, E., Yvind, K., Mørk, J.
Pages: 1015-1017
Frequency unlimited optical delay lines based on slow and fast light in SOAs
We experimentally demonstrate that up-converted coherent population oscillations (CPO) in SOA open the possibility to conceive integrated optical tunable delay lines beyond the carrier lifetime limit, up to THz frequencies.

InAs/InGaAsP Quantum Dots Emitting at 1.5 μm for Applications in Lasers
In this work the epitaxial growth of InAs quantum dots (QDs) in an InGaAsP matrix on an InP wafer is described. A new approach to shift the emission wavelength to the 1.5μm region using deposition of a thin GaAs capping layer on top of the QDs is suggested and exploited. Laser structures based on 5 layers of such dots as the gain material demonstrate lasing in continuous wave regime at 1.5 μm wavelength at room temperature.
Investigating the chemical and morphological evolution of GaAs capped InAs/InP quantum dots emitting at 1.5μm using aberration-corrected scanning transmission electron microscopy

The emission wavelength of InAs quantum dots grown on InP has been shown to shift to the technologically desirable 1.5μm with the deposition of 1–2 monolayers of GaAs on top of the quantum dots. Here, we use aberration-corrected scanning transmission electron microscopy to investigate morphological and compositional changes occurring to the quantum dots as a result of the deposition of 1.7 monolayers of GaAs on top of them, prior to complete overgrowth with InP. The results are compared with theoretical models describing the overgrowth process.

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices, Center for Electron Nanoscopy
Contributors: Kadkhodazadeh, S., Semenova, E., Yvind, K., Dunin-Borkowski, R. E.
Pages: 57-61
Publication date: 2011
Peer-reviewed: Yes

Publication information
Journal: Journal of Crystal Growth
Volume: 329
Issue number: 1
ISSN (Print): 0022-0248
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 1.78 SJR 0.592 SNIP 1.066
Web of Science (2017): Impact factor 1.742
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.69 SJR 0.742 SNIP 1.113
Web of Science (2016): Impact factor 1.751
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 1.63 SJR 0.686 SNIP 1.066
Web of Science (2015): Impact factor 1.462
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 1.69 SJR 0.786 SNIP 1.14
Web of Science (2014): Impact factor 1.698
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 1.78 SJR 0.826 SNIP 1.191
Web of Science (2013): Impact factor 1.693
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 1.68 SJR 0.954 SNIP 1.236
Web of Science (2012): Impact factor 1.552
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 1.89 SJR 0.962 SNIP 1.407
Web of Science (2011): Impact factor 1.726
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.157 SNIP 1.197
Web of Science (2010): Impact factor 1.746
Metal organic vapor-phase epitaxy of InAs/InGaAsP quantum dots for laser applications at 1.5 μm

The epitaxial growth of InAs/InGaAsP quantum dots (QDs) for emission around 1.5 μm by depositing a thin layer of GaAs on top of the QDs is presented in this letter. The influence of various growth parameters on the properties of the QDs, in particular, size, shape, chemical composition, and emission wavelength are investigated. Continuous wave lasing in ridge waveguide QD laser structures in the 1.5 μm wavelength range is demonstrated. VC 2011 American Institute of Physics. [doi:10.1063/1.3634029]
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 2.47 SJR 1.499 SNIP 1.226
Web of Science (2015): Impact factor 3.142
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 3.25 SJR 1.861 SNIP 1.492
Web of Science (2014): Impact factor 3.302
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 3.77 SJR 2.146 SNIP 1.633
Web of Science (2013): Impact factor 3.515
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 3.76 SJR 2.57 SNIP 1.739
Web of Science (2012): Impact factor 3.794
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 4.04 SJR 2.814 SNIP 1.917
Web of Science (2011): Impact factor 3.844
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.92 SNIP 1.775
Web of Science (2010): Impact factor 3.841
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 2.826 SNIP 1.834
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 2.894 SNIP 1.82
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 3.012 SNIP 1.916
Web of Science (2007): Indexed yes
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 3.755 SNIP 2.353
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 3.992 SNIP 2.367
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 3.897 SNIP 2.275
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 4.018 SNIP 2.414
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 4.281 SNIP 2.22
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 4.178 SNIP 2.017
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 4.173 SNIP 2.066

Original language: English
Electronic versions:
Non-Degenerate Four-Wave Mixing in a Silicon Nanowire and its Application for One-to-Six WDM Multicasting

We present WDM multicasting based on non-degenerate four-wave mixing in a silicon nanowire. A one-to-six phase-preserving wavelength multicasting of 10 Gb/s differential phase-shift-keying data is experimentally demonstrated with bit-error rate measurements.

Numerical modeling in photonic crystals integrated technology: the COPERNICUS Project

Photonic crystals will play a fundamental role in the future of optical communications. The relevance of the numerical modeling for the success of this technology is assessed by using some examples concerning the experience of the COPERNICUS Project.
One-to-six WDM multicasting of DPSK signals based on dual-pump four-wave mixing in a silicon waveguide

We present WDM multicasting based on dual-pump four-wave mixing in a 3-mm long dispersion engineered silicon waveguide. One-to-six phase-preserving WDM multicasting of 10-Gb/s differential phase-shiftkeying (DPSK) data is experimentally demonstrated with bit-error rate measurements. All the six multicast signals show error-free performance with power penalty less than 3.8 dB.

General information
State: Published
Organisations: Nanophotonic Devices, Department of Photonics Engineering, High-Speed Optical Communication, Quantum and Laser Photonics
Pages: 24448-24453
Publication date: 2011
Peer-reviewed: Yes

Publication information
Journal: Optics Express
Volume: 19
Issue number: 24
ISSN (Print): 1094-4087
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.74 SJR 1.519 SNIP 1.567
Web of Science (2017): Impact factor 3.356
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.48 SJR 1.532 SNIP 1.544
Web of Science (2016): Impact factor 3.307
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 3.78 SJR 1.91 SNIP 1.674
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 4.18 SJR 2.313 SNIP 2.124
Web of Science (2014): Impact factor 3.488
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 4.38 SJR 2.337 SNIP 2.196
Web of Science (2013): Impact factor 3.525
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 3.85 SJR 2.562 SNIP 2.108
Web of Science (2012): Impact factor 3.546
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 4.04 SJR 2.58 SNIP 2.572
Web of Science (2011): Impact factor 3.587
ISI indexed (2011): ISI indexed yes
Optical Waveform Sampling and Error-Free Demultiplexing of 1.28 Tb/s Serial Data in a Nanoengineered Silicon Waveguide

This paper presents the experimental demonstrations of using a pure nanoengineered silicon waveguide for 1.28 Tb/s serial data optical waveform sampling and 1.28 Tb/s–10 Gb/s error free demultiplexing. The 330-fs pulses are resolved in each 780-fs time slot in waveform sampling. Error-free operation is achieved in the 1.28 Tb/s–10 Gb/s demultiplexing.
Quantitative strain mapping of InAs/InP quantum dots with 1 nm spatial resolution using dark field electron holography

The optical properties of semiconductor quantum dots are greatly influenced by their strain state. Dark field electron holography has been used to measure the strain in InAs quantum dots grown in InP with a spatial resolution of 1 nm. A strain value of 5.4%±0.1% has been determined which is consistent with both measurements made by geometrical phase analysis of high angle annular dark field scanning transmission electron microscopy images and with simulations.

General information
State: Published
Organisations: Center for Electron Nanoscopy, Nanophotonic Devices, Department of Photonics Engineering, French Alternative Energies and Atomic Energy Commission, FEI France
Contributors: Cooper, D., Rouviere, J., Béché, A., Kadkhodazadeh, S., Semenova, E., Yvind, K., Dunin-Borkowski, R. E.
Pages: 261911
Publication date: 2011
Peer-reviewed: Yes

Publication information
Volume: 99
Issue number: 26
ISSN (Print): 0003-6951
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.25 SJR 1.382 SNIP 1.167
Web of Science (2017): Impact factor 3.495
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.67 SJR 1.673 SNIP 1.249
Web of Science (2016): Impact factor 3.411
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 2.47 SJR 1.499 SNIP 1.226
Web of Science (2015): Impact factor 3.142
Web of Science (2015): Indexed yes
Silicon chip based wavelength conversion of ultra-high repetition rate data signals

We report on all-optical wavelength conversion of 160, 320 and 640 Gbit/s line-rate data signals using four-wave mixing in a 3.6 mm long silicon waveguide. Bit error rate measurements validate the performance within FEC limits.

General information
State: Published
Organisations: High-Speed Optical Communication, Department of Photonics Engineering, Nanophotonic Devices, Quantum and Laser Photonics
Pages: PDPA8
Publication date: 2011

Host publication information
Title of host publication: Optical Fiber Communication Conference and Exposition (OFC/NFOEC), 2011 and the National Fiber Optic Engineers Conference
Publisher: Optical Society of America
ISBN (Print): 978-1-4577-0213-6
URLs:
http://www.ofcnfoec.org/home.aspx
Source: orbit
Source-ID: 276083
Research output: Research - peer-review › Article in proceedings – Annual report year: 2011

Silicon-on-insulator polarization splitting and rotating device for polarization diversity circuits

A compact and efficient polarization splitting and rotating device built on the silicon-on-insulator platform is introduced, which can be readily used for the interface section of a polarization diversity circuit. The device is compact, with a total length of a few tens of microns. It is also simple, consisting of only two parallel silicon-on-insulator wire waveguides with different widths, and thus requiring no additional and nonstandard fabrication steps. A total insertion loss of -0.6dB and an extinction ratio of 12dB have been obtained experimentally in the whole C-band.

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonic Devices, Quantum and Laser Photonics
Contributors: Liu, L., Ding, Y., Yvind, K., Hvam, J. M.
Pages: 12646-12651
Publication date: 2011
Peer-reviewed: Yes

Publication information
Journal: Optics Express
Volume: 19
Issue number: 13
ISSN (Print): 1094-4087
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.74 SJR 1.519 SNIP 1.567
Web of Science (2017): Impact factor 3.356
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.48 SJR 1.532 SNIP 1.544
Web of Science (2016): Impact factor 3.307
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 3.78 SJR 1.91 SNIP 1.674
Silicon waveguides and carbon nanotube-based pulsed fiber lasers for ultra-high-speed optical signal processing

General information
State: Published
Organisations: Department of Photonics Engineering, High-Speed Optical Communication, Nanophotonic Devices, Quantum and Laser Photonics
Contributors: Ji, H., Hu, H., Galili, M., Oxenløwe, L. K., Pu, M., Yvind, K., Hvam, J. M., Jeppesen, P.
Publication date: 2011

Host publication information
Title of host publication: Proceedings of the International Conference on Advanced Infocomm Technology ICAIT 2011
Source: orbit
Source-ID: 317609
Research output: Research - peer-review › Article in proceedings – Annual report year: 2012

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.

General information
State: Published
Organisations: High-Speed Optical Communication, Department of Photonics Engineering, Nanophotonic Devices, South China Normal University, Wuhan University of Science and Technology
Contributors: Ding, Y., Liu, L., Peucheret, C., Xu, J., Ou, H., Yvind, K., Zhang, X., Huang, D.
Pages: 1808-1810
Publication date: 2011
Peer-reviewed: Yes

Publication information
Journal: IEEE Photonics Technology Letters
Volume: 23
Issue number: 23
ISSN (Print): 1041-1135
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 2.84 SJR 0.961 SNIP 1.25
Web of Science (2017): Impact factor 2.446
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.52 SJR 0.989 SNIP 1.224
Web of Science (2016): Impact factor 2.375
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 2.62 SJR 1.19 SNIP 1.266
Web of Science (2015): Impact factor 1.945
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 2.78 SJR 1.421 SNIP 1.583
Web of Science (2014): Impact factor 2.11
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 2.95 SJR 1.495 SNIP 1.548
Web of Science (2013): Impact factor 2.176
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 2.46 SJR 1.647 SNIP 1.694
Web of Science (2012): Impact factor 2.038
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 2.48 SJR 1.539 SNIP 2.04
Web of Science (2011): Impact factor 2.191
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.457 SNIP 1.678
Web of Science (2010): Impact factor 1.989
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.721 SNIP 1.913
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.975 SNIP 1.864
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 2.224 SNIP 1.678
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 2.012 SNIP 1.869
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 2.882 SNIP 2.411
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 3.092 SNIP 2.689
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 3.17 SNIP 2.436
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 2.97 SNIP 2.1
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 3.43 SNIP 1.656
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 2.636 SNIP 1.199
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 2.564 SNIP 1.279

Original language: English
Keywords: Integrated optics devices, Microring resonator, Nonreturn-to-zero differential phase-shift keying (NRZ-DPSK) demodulation, Polarization diversity
DOIs:
10.1109/LPT.2011.2169776
Towards quantitative three-dimensional characterisation of buried InAs quantum dots

InAs quantum dots grown on InP or InGaAsP are used for optical communication applications operating in the 1.3 – 1.55 μm wavelength range. It is generally understood that the optical properties of such dots are highly dependent on their structural and chemical profiles. However, morphological and compositional measurements of quantum dots using transmission electron microscopy can be ambiguous because the recorded signal is usually a projection through the thickness of the specimen. Here, we discuss the application of scanning transmission electron microscopy tomography to the morphological and chemical characterisation of surface and buried quantum dots. We highlight some of the challenges involved and introduce a new specimen preparation method for creating needle-shaped specimens that each contain multiple dots and are suitable for both scanning transmission electron microscopy tomography and atom probe tomography.
Towards quantitative three-dimensional characterisation of InAs quantum dots

InAs quantum dots (QDs) grown on InP or InGaAsP are used for optical communication applications operating in the 1.3 – 1.55 μm wavelength range. It is generally understood that the optical properties of such QDs are highly dependent on their three-dimensional structural and chemical profiles. Whilst conventional transmission electron microscopy (TEM) techniques can be used to study capped QDs in plan-view or cross-sectional geometries, the resulting images can provide ambiguous information about their three-dimensional properties. Here, we describe an approach for investigating the applicability of both high-angle annular dark-field (HAADF) scanning transmission electron microscopy (STEM) tomography and atom probe tomography (APT) to the study of surface and buried InAs/InGaAsP QDs grown by metal organic vapour phase epitaxy (MOVPE). Electron tomography was carried out in an FEI Titan TEM instrument operated at 300 kV. TEM specimens were prepared in plan-view geometry using mechanical grinding, polishing and Ar ion milling.

Both original HAADF STEM images and final tomographic reconstruction of surface QDs suggest an elongated hexagonal shape for the bases of the QDs (Figure 1). The elongation direction was determined to be [110], using selected area electron diffraction and atomic force microscopy. The HAADF STEM images also suggest that surface QDs have a double-terraced geometry, with steeper facets around their bases and shallower facets close to their tops. This geometry is consistent with a theoretical model of InAs QDs formed on an InGaAs substrate that is lattice matched to InP [1] shown in Figure 1(b). Despite the large inner detector semi-angle used (approximately 50 mrad), strong diffraction effects were present in the original tilt series of HAADF STEM images, resulting in departure from the projection requirement for electron tomography, which states that the recorded intensity should be a monotonic function of a property of the object [2]. These diffraction effects are likely to be associated with diffraction and may lead to artefacts in the tomographic reconstruction. The same tomographic analysis was applied to a buried InAs/InGaAsP QD (Figure 1(d) and (e)). The buried QD appears to be elongated along the [110] direction, although not as strongly as the surface QD. Similarly, the faceting that is clearly visible in both the original HAADF STEM images and the final reconstruction of the surface QD, is not as pronounced for the buried QD. This difference may result from chemical intermixing between the buried QD and the capping material during overgrowth. A limiting constraint in STEM tomography of thin film specimens is the limited tilt range available before the specimen becomes too thick for imaging. This limitation can, in principle, be overcome by fabricating needle-shaped specimens using focused ion beam (FIB) milling, in order to allow unlimited tilting without significant increase in projected specimen thickness. However, FIB milling can introduce considerable damage into III-V semiconductors, including amorphisation and Ga ion implantation [3]. We have fabricated needle-shaped specimens that are 100 nm in diameter, using reactive ion etching, selective wet etching and critical point drying in plan-view geometry (Figure 2). The choice of a plan-view geometry for the needles means that each specimen will contain several QDs. The needles can either be detached from the substrate by cleaving (Figure 2(b)) or lifted out and mounted onto suitable grids using a micro-manipulator in the FIB with minimal additional damage (Figure 2(c)). Significantly, in addition to their suitability for electron tomography, these specimens can be used for APT, for which needle-shaped specimens with sharp tips (narrower than 100 nm) are required. Our ongoing experiments involve the application of both HAADF STEM tomography and APT to the same QD, in order to better understand its morphology and composition. A comparison between reconstructions obtained using both techniques will also assist in the evaluation and mitigation of potential artefacts that are present when using each technique.

General information
State: Published
Organisations: Center for Electron Nanoscopy, Nanophotonic Devices, Department of Photonics Engineering, Chalmers University of Technology
Tunable complex-valued multi-tap microwave photonic filter based on single silicon-on-insulator microring resonator

A complex-valued multi-tap tunable microwave photonic filter based on single silicon-on-insulator microring resonator is presented. The degree of tunability of the approach involving two, three and four taps is theoretical and experimentally characterized, respectively. The constraints of exploiting the optical phase transfer function of a microring resonator aiming at implementing complex-valued multi-tap filtering schemes are also reported. The trade-off between the degree of tunability without changing the free spectral range and the number of taps is studied in-depth. Different window based scenarios are evaluated for improving the filter performance in terms of the side-lobe level.
Two Photon Induced Lasing in 1550 nm Quantum Dash Optical Gain Media

We report on a unique lasing mechanism observed in quantum dash Gain media. While the gain media is electrically pumped below lasing threshold, a strong optical pulse excites carriers by two photon absorption into high energy states of the quantum dashes and wetting layer. Fast inter band carrier relaxation and capture processes into the ground states of the quantum dashes result in increased gain followed by lasing at the gain peak irrespective of the stimulating pulse wavelength. The temporal response of the lasing line is examined on a 40 GHz scope and full characterization of the pulse by the XFROG scheme is performed. We show the lasing mechanism to be governed mainly by the wetting layer dynamics and extract a direct measurement of the carrier-carrier scattering time constant.

General information
State: Published
Organisations: Nanophotonic Devices, Department of Photonics Engineering, Technion-Israel Institute of Technology, University of Kassel
Contributors: Capua, A., Saal, A., Reithmaier, J. P., Yvind, K., Eisenstein, G.
Pages: Tu.6.LeSaleve
Publication date: 2011

Host publication information
Title of host publication: Proceedings of the European Conference on Optical Communication (ECOC) 2011
Publisher: Optical Society of America
ISBN (Print): 978-1-4577-1918-9
Electronic versions: C2812d01.pdf
URLs: http://www.ecoc2011.org/

Bibliographical note
This paper was published by OSA and is made available as an electronic reprint with the permission of OSA. The paper can be found at the following URL on the OSA website: http://www.opticsinfobase.org/abstract.cfm?URI=ECOC-2011-Tu.6.LeSaleve.4. Systematic or multiple reproduction or distribution to multiple locations via electronic or other means is prohibited and is subject to penalties under law.

Source: orbit
Source-ID: 286150
Research output: Research - peer-review › Article in proceedings – Annual report year: 2011

Ultra-Broadband Tunable Wavelength Conversion of Sub-Picosecond Pulses in a Silicon Nanowire

We present a tunable wavelength conversion of sub-picosecond pulses based on fourwave mixing in a dispersion engineered silicon nanowire. A 100-nm tuning range of the converted wavelength is demonstrated with an almost constant conversion efficiency.

General information
State: Published
Organisations: Nanophotonic Devices, Department of Photonics Engineering, High-Speed Optical Communication, Quantum and Laser Photonics
Pages: CMAA1
Publication date: 2011

Host publication Information
Title of host publication: 2011 Conference on Lasers and Electro-Optics (CLEO)
Publisher: Optical Society of America
ISBN (Print): 978-1-4577-1223-4
URLs: http://www.cleoconference.org/
Source: orbit
Source-ID: 276542
Research output: Research - peer-review › Article in proceedings – Annual report year: 2011
Ultra-Fast Optical Signal Processing in Nonlinear Silicon Waveguides

We describe recent demonstrations of exploiting highly nonlinear silicon nanowires for processing Tbit/s optical data signals. We perform demultiplexing and optical waveform sampling of 1.28 Tbit/s and wavelength conversion of 640 Gbit/s data signals.

General information
State: Published
Organisations: Department of Photonics Engineering, High-Speed Optical Communication, Nanophotonic Devices, Quantum and Laser Photonics
Pages: 335-337
Publication date: 2011

Host publication information
Title of host publication: 2011 8th IEEE International Conference on Group IV Photonics (GFP)
Publisher: IEEE
ISBN (Print): 978-1-4244-8338-9
DOIs: 10.1109/GROUP4.2011.6053808
URLs: http://www.photonicsconferences.org/GFP2011/
Source: orbit
Source-ID: 286890
Research output: Research - peer-review › Article in proceedings – Annual report year: 2011

Ultra-high-speed optical serial-to-parallel data conversion by time-domain optical Fourier transformation in a silicon nanowire

We demonstrate conversion from $64 \times 10$ Gbit/s optical timedivision multiplexed (OTDM) data to dense wavelength division multiplexed (DWDM) data with 25 GHz spacing. The conversion is achieved by time-domain optical Fourier transformation (OFT) based on four-wave mixing (FWM) in a 3.6 mm long silicon nanowire. A total of 40 out of 64 tributaries of a $64 \times 10$ Gbit/s OTDM-DPSK data signal are simultaneously converted with a bit-error rate (BER) performance below the $2 \times 10^{-3}$ FEC limit. Using a 50 m long highly nonlinear fiber (HNLF) for higher FWM conversion efficiency, 43 tributaries of a $64 \times 10$ Gbit/s OTDM-OOK data signal are converted with error-free performance (BER

General information
State: Published
Organisations: High-Speed Optical Communication, Department of Photonics Engineering, Nanophotonic Devices, Quantum and Laser Photonics
Pages: B825-B835
Publication date: 2011
Peer-reviewed: Yes

Publication information
Journal: Optics Express
Volume: 19
Issue number: 26
ISSN (Print): 1094-4087
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.74 SJR 1.519 SNIP 1.567
Web of Science (2017): Impact factor 3.356
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.48 SJR 1.532 SNIP 1.544
Web of Science (2016): Impact factor 3.307
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 3.78 SJR 1.91 SNIP 1.674
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 4.18 SJR 2.313 SNIP 2.124
Web of Science (2014): Impact factor 3.488
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 4.38 SJR 2.337 SNIP 2.196
Web of Science (2013): Impact factor 3.525
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 3.85 SJR 2.562 SNIP 2.108
Web of Science (2012): Impact factor 3.546
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 4.04 SJR 2.58 SNIP 2.572
Web of Science (2011): Impact factor 3.587
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.906 SNIP 2.428
Web of Science (2010): Impact factor 3.753
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 3.039 SNIP 2.679
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 3.204 SNIP 2.423
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 3.284 SNIP 2.11
Web of Science (2007): Indexed yes
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 3.313 SNIP 2.336
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 2.819 SNIP 2.472
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 2.669 SNIP 2.217
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 1.745 SNIP 1.748
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 1.496 SNIP 1.42
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 0.98 SNIP 0.761
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 1.442 SNIP 0.843

Original language: English
Ultra-High-Speed Optical Serial-to-Parallel Data Conversion in a Silicon Nanowire

We demonstrate conversion from 64×10 Gbit/s OTDM to 25 GHz DWDM by time-domain optical Fourier transformation. Using a single silicon nanowire, 40 of 64 OTDM tributaries are simultaneously converted to DWDM channels within FEC limits.

General information
State: Published
Organisations: High-Speed Optical Communication, Department of Photonics Engineering, Nanophotonic Devices, Quantum and Laser Photonics
Pages: Th.13.A.2
Publication date: 2011

Ultra-high-speed wavelength conversion in a silicon photonic chip

We have successfully demonstrated all-optical wavelength conversion of a 640-Gbit/s line-rate return-to-zero differential phase-shift keying (RZ-DPSK) signal based on low-power four wave mixing (FWM) in a silicon photonic chip with a switching energy of only ~110 fJ/bit. The waveguide dispersion of the silicon nanowire is nano-engineered to optimize phase matching for FWM and the switching power used for the signal processing is low enough to reduce nonlinear absorption from twophoton- absorption (TPA). These results demonstrate that high-speed wavelength conversion is achievable in silicon chips with high data integrity and indicate that high-speed operation can be obtained at moderate power levels where nonlinear absorption due to TPA and free-carrier absorption (FCA) is not detrimental. This demonstration can potentially enable highspeed optical networks on a silicon photonic chip.

General information
State: Published
Organisations: High-Speed Optical Communication, Department of Photonics Engineering, Nanophotonic Devices, Quantum and Laser Photonics
Pages: 19886-19894
Publication date: 2011
10-GHz 1.59-μm quantum dash passively mode-locked two-section lasers

This paper reports the fabrication and the characterisation of a 10 GHz two-section passively mode-locked quantum dash laser emitting at 1.59 μm. The potential of the device's mode-locking is investigated through an analytical model taking into account both the material parameters and the laser geometry. Results show that the combination of a small absorbing section coupled to a high absorption coefficient can lead to an efficient mode-locking. Characterisation shows mode-locking operation though output pulses are found to be strongly chirped. Noise measurements demonstrate that the single side band phase noise does not exceed -80 dBc/Hz at 100 kHz offset leading to an average timing jitter as low as 800 fs. As compared to single QW lasers these results constitute a significant improvement and are of first importance for applications in optical telecommunications.
This letter demonstrates optical demultiplexing of a 1.28-Tb/s serial differential phase-shift-keying data signal using a nano-engineered silicon waveguide. We first present error-free performance at 640 Gb/s and then at 1.28 Tb/s with characterization of all 128 channels. Bit-error rates below $10^{-9}$ are achieved for some channels and below forward-error-correction limit for all channels, corresponding to a 1.19-Tb/s error-free data signal.
360° tunable microwave phase shifter based on silicon-on-insulator dual-microring resonator

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.
BROADBAND TRAVELLING WAVE SEMICONDUCTOR OPTICAL AMPLIFIER

Broadband travelling wave semiconductor optical amplifier (100, 200, 300, 400, 800) for amplification of light, wherein the amplifier (100, 200, 300, 400, 800) comprises a waveguide region (101, 201, 301, 401, 801) for providing confinement of the light in transverse directions and adapted for propagation of the light in at least a first mode along a longitudinal axis (102, 202, 302) of the amplifier (100, 200, 300, 400, 800) in a propagation direction (103, 203, 303), and wherein the waveguide region (101, 201, 301, 401, 801) comprises a gain region (104, 204, 304, 404, 804) for amplifying the light and an outer region (105, 205, 305, 405, 805); the waveguide region (101, 201, 301, 401, 801) having a width (106, 206, 306) and a height, and the gain region (104, 204, 304, 404, 804) having a width (107, 207, 307) and a height, wherein the width (106, 206, 306) of the waveguide region (101, 201, 301, 401, 801) increases along the longitudinal axis (102, 202, 302), and wherein the ratio between the width (106, 206, 306) of the waveguide region (101, 201, 301, 401, 801) and the width (107, 207, 307) of the gain region (104, 204, 304, 404, 804) increases along the longitudinal axis (102, 202, 302).

Comparison of the noise performance of 10GHz QW and QD mode-locked laser diodes

This paper reports the experimental characterization of the noise performance of a quantum dot and a quantum well 10GHz passive mode locked laser diodes.
Enhanced amplified spontaneous emission in III-V semiconductor photonic crystal waveguides
We experimentally demonstrate enhanced amplified spontaneous emission in the slow light regime of an active photonic crystal waveguide slab. This promises great opportunities for future devices such as miniaturized semiconductor optical amplifiers and mode-locked lasers.

General information
State: Published
Organisations: Quantum and Laser Photonics, Department of Photonics Engineering, Nanophotonic Devices
Contributors: Ek, S., Schubert, M., Yvind, K., Mørk, J.
Publication date: 2010

Host publication information
Title of host publication: Proceedings IPR
Source: orbit
Source-ID: 271095
Research output: Research - peer-review › Article in proceedings – Annual report year: 2010

Fully-etched photonic crystal grating coupler as an interface between single-mode fibers and photonic circuits on silicon-on-insulator
A grating coupler for interfacing between single-mode fibers and photonic circuits on silicon-on-insulator is demonstrated. It consists of columns of fully etched photonic crystal holes, which are made in the same lithography and etching processes used for making the silicon-on-insulator wire waveguide. The holes have a diameter of around 143 nm, and are defined with electron-beam lithography. A peak coupling efficiency of 42% at 1550 nm and 1 dB bandwidth of 37 nm, as well as a low back reflection, are achieved. The performance of the proposed fully etched grating coupler is comparable to that based on the conventional shallowly etched grating, which needs additional fabrication steps.

General information
State: Published
Organisations: Nanophotonic Devices, Department of Photonics Engineering, Quantum and Laser Photonics
Contributors: Liu, L., Pu, M., Yvind, K., Hvam, J. M.
Pages: 1-3
Publication date: 2010

Host publication information
Title of host publication: Optical Fiber Communication (OFC), collocated National Fiber Optic Engineers Conference, 2010 Conference on (OFC/NFOEC)
Publisher: IEEE
ISBN (Print): 978-1-55752-884-1
URLs:
http://www.ofcnoec.org/about_ofc/index.aspx
Source: orbit
Source-ID: 262323
Research output: Research - peer-review › Article in proceedings – Annual report year: 2010

High-efficiency, large-bandwidth silicon-on-insulator grating coupler based on a fully-etched photonic crystal structure
A grating coupler for interfacing between single-mode fibers and photonic circuits on silicon-on-insulator is demonstrated. It consists of columns of fully etched photonic crystal holes, which are made in the same lithography and etching processes used for making the silicon-on-insulator wire waveguide. The holes have a diameter of around 143 nm, and are defined with electron-beam lithography. A peak coupling efficiency of 42% at 1550 nm and 1 dB bandwidth of 37 nm, as well as a low back reflection, are achieved. The performance of the proposed fully etched grating coupler is comparable to that based on the conventional shallowly etched grating, which needs additional fabrication steps.

General information
State: Published
Organisations: Nanophotonic Devices, Department of Photonics Engineering, Quantum and Laser Photonics
Contributors: Liu, L., Pu, M., Yvind, K., Hvam, J. M.
Pages: 051126
Publication date: 2010
Peer-reviewed: Yes

Publication information
Volume: 96
Issue number: 5
ISSN (Print): 0003-6951
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
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Investigations of repetition rate stability of a mode-locked quantum dot semiconductor laser in an auxiliary optical fiber cavity

We have investigated experimentally the pulse train (mode beating) stability of a monolithic mode-locked multi-section quantum-dot laser with an added passive auxiliary optical fiber cavity. Addition of the weakly coupled (¿ -24dB) cavity reduces the current-induced shift d¿/dI of the principal peak in the RF spectrum (the effective pulse repetition frequency) by more than an order of magnitude, from -39.5 to -2.3 kHz/mA. The rms timing jitter of the pulse train is simultaneously reduced from 1.4 to 0.9 ps.
Lambda shifted photonic crystal cavity laser

We propose and demonstrate an alternative type of photonic crystal laser design that shifts all the holes in the lattice by a fixed fraction of the targeted emission wavelength. The structures are realized in InGaAsP =1.15 with InGaAsP quantum wells =1.52 as gain material. Cavities with shifts of 1/4 and 3/4 of the emission wavelength were fabricated and characterized. Measurements show threshold behavior for several modes at room temperature. Both structures are simulated using a finite difference time domain method to identify the resonances in the spectra and calculate the mode
volume of the dominant mode.

**General information**

**State:** Published  
**Organisations:** Nanophotonic Devices, Department of Photonics Engineering, Quantum and Laser Photonics  
**Contributors:** Schubert, M., Skovgård, T. S., Ek, S., Semenova, E., Hvam, J. M., Yvind, K.  
**Pages:** 191109  
**Publication date:** 2010  
**Peer-reviewed:** Yes

**Publication information**  
**Journal:** Applied Physics Letters  
**Volume:** 97  
**Issue number:** 19  
**ISSN (Print):** 0003-6951  
**Ratings:**  
- BFI (2019): BFI-level 2  
- Web of Science (2019): Indexed yes  
- BFI (2018): BFI-level 2  
- Web of Science (2018): Indexed yes  
- BFI (2017): BFI-level 2  
- Scopus rating (2017): CiteScore 3.25 SJR 1.382 SNIP 1.167  
- Web of Science (2017): Impact factor 3.495  
- Web of Science (2017): Indexed yes  
- BFI (2016): BFI-level 2  
- Scopus rating (2016): CiteScore 2.67 SJR 1.673 SNIP 1.249  
- Web of Science (2016): Impact factor 3.411  
- Web of Science (2016): Indexed yes  
- BFI (2015): BFI-level 2  
- Scopus rating (2015): CiteScore 2.47 SJR 1.499 SNIP 1.226  
- Web of Science (2015): Indexed yes  
- BFI (2014): BFI-level 2  
- Scopus rating (2014): CiteScore 3.25 SJR 1.861 SNIP 1.492  
- Web of Science (2014): Impact factor 3.302  
- Web of Science (2014): Indexed yes  
- BFI (2013): BFI-level 2  
- Scopus rating (2013): CiteScore 3.77 SJR 2.146 SNIP 1.633  
- Web of Science (2013): Impact factor 3.515  
- ISI indexed (2013): ISI indexed yes  
- Web of Science (2013): Indexed yes  
- BFI (2012): BFI-level 2  
- Scopus rating (2012): CiteScore 3.76 SJR 2.57 SNIP 1.739  
- Web of Science (2012): Impact factor 3.794  
- ISI indexed (2012): ISI indexed yes  
- Web of Science (2012): Indexed yes  
- BFI (2011): BFI-level 2  
- Scopus rating (2011): CiteScore 4.04 SJR 2.814 SNIP 1.917  
- Web of Science (2011): Impact factor 3.844  
- ISI indexed (2011): ISI indexed yes  
- Web of Science (2011): Indexed yes  
- BFI (2010): BFI-level 2  
- Scopus rating (2010): SJR 2.92 SNIP 1.775  
- Web of Science (2010): Impact factor 3.841  
- Web of Science (2010): Indexed yes  
- BFI (2009): BFI-level 2
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.

**General information**

State: Published
Organisations: Nanophotonic Devices, Department of Photonics Engineering, Quantum and Laser Photonics
Contributors: Pu, M., Liu, L., Xue, W., Frandsen, L. H., Ou, H., Yvind, K., Hvam, J. M.
Pages: 1-2
Publication date: 2010

**Host publication information**

Title of host publication: 2010 Conference on Lasers and Electro-Optics (CLEO) and Quantum Electronics and Laser Science Conference (QELS)
Publisher: IEEE
ISBN (Print): 978-1-55752-889-6
Electronic versions:
Pu.pdf
URLs:
http://www.cleoconference.org/

**Bibliographical note**

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Source: orbit
Source-ID: 262387
Research output: Research - peer-review › Article in proceedings – Annual report year: 2010
Modulation response of nanoLEDs and nanolasers exploiting Purcell enhanced spontaneous emission

The modulation bandwidth of quantum well nanoLED and nanolaser devices is calculated from the laser rate equations using a detailed model for the Purcell enhanced spontaneous emission. It is found that the Purcell enhancement saturates when the cavity quality-factor is increased, which limits the maximum achievable spontaneous recombination rate. The modulation bandwidth is thereby limited to a few tens of GHz for realistic devices.

General information
State: Published
Organisations: Quantum and Laser Photonics, Department of Photonics Engineering, Nanophotonic Devices
Contributors: Skovgård, T. S., Gregersen, N., Yvind, K., Mørk, J.
Pages: 11230-11241
Publication date: 2010
Peer-reviewed: Yes

Publication information
Journal: Optics Express
Volume: 18
Issue number: 11
ISSN (Print): 1094-4087
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.74 SJR 1.519 SNIP 1.567
Web of Science (2017): Impact factor 3.356
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.48 SJR 1.532 SNIP 1.544
Web of Science (2016): Impact factor 3.307
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BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 3.78 SJR 1.91 SNIP 1.674
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Scopus rating (2014): CiteScore 4.18 SJR 2.313 SNIP 2.124
Web of Science (2014): Impact factor 3.488
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BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 4.38 SJR 2.337 SNIP 2.196
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ISI indexed (2013): ISI indexed yes
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BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 3.85 SJR 2.562 SNIP 2.108
Web of Science (2012): Impact factor 3.546
ISI indexed (2012): ISI indexed yes
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BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 4.04 SJR 2.58 SNIP 2.572
Web of Science (2011): Impact factor 3.587
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
Optical waveform sampling and error-free demultiplexing of 1.28 Tbit/s serial data in a silicon nanowire: [post deadline]
We experimentally demonstrate 640 Gbit/s and 1.28 Tbit/s serial data optical waveform sampling and 640-to-10 Gbit/s and 1.28 Tbit/s-to-10 Gbit/s error-free demultiplexing using four-wave mixing in a 300nm$$450nm$$5mm silicon nanowire.

General information
State: Published
Organisations: High-Speed Optical Communication, Department of Photonics Engineering, Nanophotonic Devices, Quantum and Laser Photonics, Administration
Contributors: Ji, H., Hu, H., Galili, M., Oxenløwe, L. K., Pu, M., Yvind, K., Hvam, J. M., Jeppesen, P.
Pages: 1-3
Publication date: 2010

Host publication information
Title of host publication: 2010 Conference on (OFC/NFOEC) Optical Fiber Communication (OFC), collocated National Fiber Optic Engineers Conference
Publisher: IEEE
Electronic versions:
Ji.pdf

Bibliographical note
Copyright 2010 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
Optimization of VCSELs for Self-Mixing Sensing
We have simulated the variations in optical output power from a vertical-cavity surface-emitting laser (VCSEL) subject to self-mixing feedback, which is very important for applications in sensing. In order to maximize the self-mixing signal for a given feedback we have optimized the epitaxial design of the VCSEL. The most important parameters are the number of quantum wells (gain), the number of Bragg mirrors (reflection), and the detector position.

General information
State: Published
Organisations: Nanophotonic Devices, Department of Photonics Engineering, Quantum and Laser Photonics
Contributors: Larsson, D., Yvind, K., Chung, I., Hvam, J. M.
Pages: 667-669
Publication date: 2010
Peer-reviewed: Yes

Publication information
Journal: IEEE Photonics Technology Letters
Volume: 22
Issue number: 10
ISSN (Print): 1041-1135
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
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BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 2.84 SJR 0.961 SNIP 1.25
Web of Science (2017): Impact factor 2.446
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.52 SJR 0.989 SNIP 1.224
Web of Science (2016): Impact factor 2.375
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 2.62 SJR 1.19 SNIP 1.266
Web of Science (2015): Impact factor 1.945
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 2.78 SJR 1.421 SNIP 1.583
Web of Science (2014): Impact factor 2.11
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 2.95 SJR 1.495 SNIP 1.548
Web of Science (2013): Impact factor 2.176
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 2.46 SJR 1.647 SNIP 1.694
Web of Science (2012): Impact factor 2.038
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 2.48 SJR 1.539 SNIP 2.04
We report a new method for monitoring vapor concentration of volatile organic compounds using a vertical-cavity surface-emitting laser (VCSEL). The VCSEL is coated with a polymer thin film on the top distributed Bragg reflector (DBR). The analyte absorption is transduced to the electrical domain through modulation of the VCSEL output power as the polymer swell. We have investigated the responsivity of this technique experimentally using a plasma polymerized polystyrene coating and explain the results theoretically as a reflectance modulation of the top DBR.

Polymer-coated vertical-cavity surface-emitting laser diode vapor sensor

We report a new method for monitoring vapor concentration of volatile organic compounds using a vertical-cavity surface-emitting laser (VCSEL). The VCSEL is coated with a polymer thin film on the top distributed Bragg reflector (DBR). The analyte absorption is transduced to the electrical domain through modulation of the VCSEL output power as the polymer swell. We have investigated the responsivity of this technique experimentally using a plasma polymerized polystyrene coating and explain the results theoretically as a reflectance modulation of the top DBR.

General information

State: Published
Organisations: Nanophotonic Devices, Department of Photonics Engineering, Department of Micro- and Nanotechnology, Polymer Microsystems for Cell Processing Group, Polymer Micro and Nano Engineering Section, Nanoprobes Group, NanoSystemsEngineering Section, Quantum and Laser Photonics
Pages: 76150A
Publication date: 2010
Peer-reviewed: Yes

Publication information

Journal: Proceedings of SPIE, the International Society for Optical Engineering
Volume: 7615
Pulse delay measurements in cascaded quantum well gain and absorber media

A tunable delay of ultrashort laser pulses in semiconductor waveguide structures are demonstrated in cascaded amplifying and absorbing semiconductor waveguides and compared with a single sectioned waveguide. The single sectioned waveguide shows a low transmission at the maximum delay. This is effectively avoided with the cascaded waveguide configuration, where it is demonstrated viable achieving a net pulse delay while maintaining a transmission of unity. For both type of devices, a pulse advancement is observed, at large pulse energies, that existing models are unable to account for.
Quarter-lambda-shifted photonic crystal lasers

A new design for photonic crystal lasers is proposed and realised. It allows an intuitive design for ultralow mode volume and high Q cavities which can be realized in a connected membrane structure.

General information

State: Published
Organisations: Nanophotonic Devices, Department of Photonics Engineering, Quantum and Laser Photonics
Contributors: Schubert, M., Skovgård, T. S., Ek, S., Semenova, E., Hvam, J. M., Yvind, K.
Publication date: 2010
Peer-reviewed: Yes
DOIs: 10.1109/ISLC.2010.5642717
URLs:
Silicon-on-insulator ring-shaped photonic crystal waveguides for refractive index sensing

General information
State: Published
Organisations: Nanophotonic Devices, Department of Photonics Engineering, Quantum and Laser Photonics
Contributors: Pu, M., Liu, L., Frandsen, L. H., Ou, H., Yvind, K., Hvam, J. M.
Pages: 1-3
Publication date: 2010

Host publication information
Title of host publication: 2010 Conference on (OFC/NFOEC) Optical Fiber Communication (OFC), collocated National Fiber Optic Engineers Conference
Publisher: IEEE
Electronic versions:
Pu.pdf

Bibliographical note
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Thermoplastic microcantilevers fabricated by nanoimprint lithography

Nanoimprint lithography has been exploited to fabricate micrometre-sized cantilevers in thermoplastic. This technique allows for very well defined microcantilevers and gives the possibility of embedding structures into the cantilever surface. The microcantilevers are fabricated in TOPAS and are up to 500 μm long, 100 μm wide, and 4.5 μm thick. Some of the cantilevers have built-in ripple surface structures with heights of 800 nm and pitches of 4 μm. The yield for the cantilever fabrication is 95% and the initial out-of-plane bending is below 10 μm. The stiffness of the cantilevers is measured by deflecting the cantilever with a well-characterized AFM probe. An average stiffness of 61.3 mN m−1 is found. Preliminary tests with water vapour indicate that the microcantilevers can be used directly for vapour sensing applications and illustrate the influence of surface structuring of the cantilevers.

General information
State: Published
Organisations: Nanoprobes Group, NanoSystemsEngineering Section, Department of Micro- and Nanotechnology, NSE-Optofluidics Group, Nanophotonic Devices, Department of Photonics Engineering, Quantum and Laser Photonics, University of California at Berkeley
Pages: 15009
Publication date: 2010
Peer-reviewed: Yes

Publication information
Journal: Journal of Micromechanics and Microengineering
Volume: 20
Issue number: 1
ISSN (Print): 0960-1317
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 2.02 SJR 0.554 SNIP 0.968
Web of Science (2017): Impact factor 1.888
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.74 SJR 0.63 SNIP 1.067
Web of Science (2016): Impact factor 1.794
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 1.96 SJR 0.687 SNIP 1.265
Web of Science (2015): Impact factor 1.768
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 1.84 SJR 0.802 SNIP 1.316
Web of Science (2014): Impact factor 1.731
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 1.74 SJR 0.737 SNIP 1.233
Web of Science (2013): Impact factor 1.725
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 1.92 SJR 0.936 SNIP 1.491
Web of Science (2012): Impact factor 1.79
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 2.43 SJR 1.036 SNIP 1.443
Web of Science (2011): Impact factor 2.105
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.013 SNIP 1.637
Web of Science (2010): Impact factor 2.281
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.144 SNIP 1.5
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.243 SNIP 1.616
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.422 SNIP 1.815
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.264 SNIP 2.098
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.165 SNIP 2.073
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 1.057 SNIP 1.881
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 1.416 SNIP 1.579
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 1.103 SNIP 1.507
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 0.763 SNIP 1.651
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 0.741 SNIP 1.011
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.

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.
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.
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.

General information
State: Published
Organisations: Nanophotonic Devices, Department of Photonics Engineering, Quantum and Laser Photonics
Contributors: Pu, M., Liu, L., Ou, H., Yvind, K., Hvam, J. M.
Pages: Tu.5.C.6
Publication date: 2010

Host publication information
Title of host publication: European Conference on Optical Communication, ECOC
Volume: 1-2
Publisher: IEEE
ISBN (Print): 9781424485352
Source: orbit
Source-ID: 267693
Research output: Research - peer-review › Article in proceedings – Annual report year: 2010

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.

General information
State: Published
Organisations: Nanophotonic Devices, Department of Photonics Engineering, Quantum and Laser Photonics
Contributors: Pu, M., Liu, L., Xue, W., Ding, Y., Ou, H., Yvind, K., Hvam, J. M.
Pages: 6172-6182
Publication date: 2010
Peer-reviewed: Yes

Publication information
Journal: Optics Express
Volume: 18
Issue number: 6
ISSN (Print): 1094-4087
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.74 SJR 1.519 SNIP 1.567
Web of Science (2017): Impact factor 3.356
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.48 SJR 1.532 SNIP 1.544
Web of Science (2016): Impact factor 3.307
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 3.78 SJR 1.91 SNIP 1.674
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Optical regeneration using a monolithically integrated chip formed by a cascade of semiconductor optical amplifiers and saturable absorbers is investigated. Static transfer functions, signal reshaping, extinction ratio enhancement, noise dynamics and device dependence on operation conditions are measured. Results show that by cascading two-pairs of SOA–EAs a steep static transfer function is achieved. Dynamical measurements show large improvements in extinction ratio as well as a large improvement in the receiver-sensitivity when used as a regenerator for NRZ signals at 10 Gb/s.

**General information**

State: Published
Organisations: Department of Photonics Engineering, Metro-Access and Short Range Systems, Nanophotonic Devices, Quantum and Laser Photonics, Technical University of Denmark
Contributors: Vivero, T., Calabretta, N., Tafur Monroy, I., Kassar, G., Öhman, F., Yvind, K., Gonzales-Marcos, A., Mørk, J.
Pages: 117-121
Publication date: 2009
Peer-reviewed: Yes

**Publication information**

Journal: Optics Communications
Volume: 282
Issue number: 1
ISSN (Print): 0030-4018
Ratings:
- BFI (2019): BFI-level 2
- Web of Science (2019): Indexed yes
- BFI (2018): BFI-level 2
- Web of Science (2018): Indexed yes
- BFI (2017): BFI-level 2
- Scopus rating (2017): CiteScore 1.86 SJR 0.614 SNIP 0.95
- Web of Science (2017): Impact factor 1.887
- Web of Science (2017): Indexed yes
- BFI (2016): BFI-level 2
- Scopus rating (2016): CiteScore 1.65 SJR 0.603 SNIP 0.87
- Web of Science (2016): Impact factor 1.588
- Web of Science (2016): Indexed yes
- BFI (2015): BFI-level 2
- Scopus rating (2015): CiteScore 1.62 SJR 0.673 SNIP 0.928
- Web of Science (2015): Impact factor 1.48
- Web of Science (2015): Indexed yes
- BFI (2014): BFI-level 2
- Scopus rating (2014): CiteScore 1.62 SJR 0.7 SNIP 1.03
- Web of Science (2014): Impact factor 1.449
- Web of Science (2014): Indexed yes
- BFI (2013): BFI-level 2
- Scopus rating (2013): CiteScore 1.78 SJR 0.74 SNIP 1.154
- Web of Science (2013): Impact factor 1.542
- ISI indexed (2013): ISI indexed yes
- Web of Science (2013): Indexed yes
- BFI (2012): BFI-level 2
- Scopus rating (2012): CiteScore 1.63 SJR 0.801 SNIP 1.125
- Web of Science (2012): Impact factor 1.438
- ISI indexed (2012): ISI indexed yes
- Web of Science (2012): Indexed yes
- BFI (2011): BFI-level 2
Acetone vapor sensing using a vertical cavity surface emitting laser diode coated with polystyrene

We report theoretical and experimental on a new vapor sensor, using a single-mode vertical-cavity surface-emitting laser (VCSEL) coated with a polymer sensor coating, which can detect acetone vapor at a volume fraction of 2.5%. The sensor provides the advantage of standard packaging, small form-factor, mechanical stability and low cost when combined with a monolithically integrated photodiode detector.

General information
State: Published
Organisations: Nanophotonic Devices, Department of Photonics Engineering, Department of Micro- and Nanotechnology, Polymer Microsystems for Cell Processing Group, Polymer Micro and Nano Engineering Section, Nanoprobes Group, NanoSystemsEngineering Section, Quantum and Laser Photonics
Publication date: 2009

Host publication information
Title of host publication: Proceedings of COMS
Source: orbit
Source-ID: 251062
Research output: Research - peer-review » Conference abstract in proceedings – Annual report year: 2009
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, Quantum and Laser Photonics
Contributors: Pu, M., Frandsen, L. H., Ou, H., Yvind, K., Hvam, J. M.
Publication date: 2009

Host publication information
Title of host publication: 2009 Frontiers in Optics(FiO)/Laser Science XXV (LS)
Place of publication: San Jose, CA, USA
Source: orbit
Source-ID: 247535
Research output: Research - peer-review › Article in proceedings – Annual report year: 2009

Optimization of self-mixing modulation in VCSELs for sensing applications
This paper numerically investigates, SMI in an oxide aperture VCSEL to optimize the epitaxial structure for higher performance. The standard investigated structure is emitting light at 970 nm from In0.17Ga0.83As-GaAsP QWs sandwiched between 36 pairs of bottom mirror and 23 pairs of top mirror (AlxGa1-xAs). The calculations are based on matrix multiplication for calculating effective reflectivity and transmission with external feedback, combined with a logarithmic gain model and standard laser rate equations. To improve the sensitivity towards self-mixing interference in VCSELs by simple epitaxial means and this should enable us to e.g. measure smaller bending deflections of cantilever sensors

General information
State: Published
Organisations: Nanophotonic Devices, Department of Photonics Engineering, Quantum and Laser Photonics
Contributors: Larsson, D., Yvind, K., Hvam, J. M.
Publication date: 2009

Host publication information
Title of host publication: CLEO/Europe-EQEC 2009
Place of publication: Munich, Germany
Publisher: IEEE
Electronic versions:
Larsson2.pdf
DOIs:
10.1109/CLEOE-EQEC.2009.5192873

Bibliographical note
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Source: orbit
Source-ID: 240752
Research output: Research - peer-review › Article in proceedings – Annual report year: 2009

Self-mixing interferometry in VCSELs for nanomechanical cantilever sensing
We have investigated optical read-out of uncoated polymer micrometer-sized cantilever sensors by self-mixing interference in VCSELs for single-molecule gas sensing. A resolution ~0.2 nm is measured, which is much better than current methods.

General information
State: Published
Organisations: Nanophotonic Devices, Department of Photonics Engineering, Nanoprobes Group, NanoSystemsEngineering Section, Department of Micro- and Nanotechnology, Quantum and Laser Photonics
Contributors: Larsson, D., Greve, A., Hvam, J. M., Boisen, A., Yvind, K.
Pages: 1-2
Publication date: 2009
Self-mixing interferometry in vertical-cavity surface-emitting lasers for nanomechanical cantilever sensing

We have experimentally investigated self-mixing interference produced by the feedback of light from a polymer micrometer-sized cantilever into a vertical-cavity surface-emitting laser for sensing applications. In particular we have investigated how the visibility of the optical output power and the junction voltage depends on the laser injection current and the distance to the cantilever. The highest power visibility obtained from cantilevers without reflective coatings was 60%, resulting in a very high sensitivity of 45 mV/nm with a noise floor below 1.2 mV. Different detection schemes are discussed.
Original language: English
Keywords: laser noise, laser feedback, cantilevers, optical polymers, light interferometry, nanomechanics, antireflection coatings, surface emitting lasers, nanosensors, optical sensors
Electronic versions: David.pdf
DOIs: 10.1063/1.3086893
URLs: http://link.aip.org/link/APPLAB/v94/i9/p091103/s1

Bibliographical note
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Source: orbit
Source-ID: 239878
Slow and fast light: Controlling the speed of light using semiconductor waveguides

We give an overview of slow- and fast-light effects in semiconductor active waveguides. Experimental and theoretical results are presented, emphasizing the physics of these phenomena and the limitations imposed by the carried dynamical processes.

General information
State: Published
Organisations: Quantum and Laser Photonics, Department of Photonics Engineering, Nanophotonic Devices
Contributors: Mørk, J., Öhman, F., Poel, M. V. D., Chen, Y., Hansen, P. L., Yvind, K.
Pages: 30-44
Publication date: 2009
Peer-reviewed: Yes

Publication information
Journal: Laser & Photonics Reviews
Volume: 3
Issue number: 1-2
ISSN (Print): 1863-8880
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 9.02 SJR 4.228 SNIP 2.988
Web of Science (2017): Impact factor 8.529
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 8.71 SJR 4.013 SNIP 3.351
Web of Science (2016): Impact factor 8.434
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 8.54 SJR 4.205 SNIP 3.479
Web of Science (2015): Impact factor 7.486
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 8.62 SJR 4.958 SNIP 4.446
Web of Science (2014): Impact factor 8.008
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 9.26 SJR 5.132 SNIP 4.796
Web of Science (2013): Impact factor 9.313
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 7.59 SJR 5.144 SNIP 3.617
Web of Science (2012): Impact factor 7.976
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 7.98 SJR 5.844 SNIP 4.857
Web of Science (2011): Impact factor 7.388
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Slow and fast light effects in semiconductor waveguides for applications in microwave photonics

We review the theory of slow and fast light effects due to coherent population oscillations in semiconductor waveguides, and potential applications of these effects in microwave photonic systems as RF phase shifters. In order to satisfy the application requirement of 360º RF phase shift at different microwave or millimeter-wave frequency bands, we present several schemes to increase the achievable RF phase shift by enhancing light slow-down or speed-up. These schemes include integrating gain and absorption sections, optical filtering and the exploitation of the initial chirp effects. As a real application in microwave photonics, a widely tunable microwave photonic notch filter with 100% fractional tuning range is also proposed and demonstrated.

General information
State: Published
Organisations: Department of Photonics Engineering
Contributors: Xue, W., Chen, Y., Öhman, F., Sales, S., Capmany, J., Yvind, K., Mørk, J.
Pages: 7226-7232
Publication date: 2009

Host publication information
Title of host publication: Proceedings of the International Society for Optical Engineering SPIE. Photonics West
Place of publication: San Jose, CA, USA
Publisher: SPIE - International Society for Optical Engineering
Source: orbit
Source-ID: 237599
Research output: Research - peer-review › Article in proceedings – Annual report year: 2009

Strip detector for nanoscale resolution

General information
State: Published
Organisations: Metal Structures in Four Dimensions, Materials Research Division, Risø National Laboratory for Sustainable Energy, Department of Photonics Engineering, Nanophotonic Devices
Contributors: Olsen, U. L., Schmidt, S., Poulsen, H. F., Yvind, K., Ottaviano, L.
Publication date: 2009

Event information
Event: Detektor Workshop
Location: Risø (DK), 27 Feb.
Keywords: Materials characterization and modelling, Materials research
Electronic versions:
Detector_presentation.pdf
Source: orbit
Source-ID: 254907
Research output: Research › Sound/Visual production (digital) – Annual report year: 2009
Sub-threshold investigation of two coupled photonic crystal cavities
The behavior of two coupled photonic crystal membrane cavities with quantum dots separated by different number of holes is investigated. The measured spectral splitting with increased coupling is verified by 3D calculations and discussed.

Sub-threshold wavelength splitting in coupled photonic crystal cavity arrays
Coupled photonic crystal (PhC) cavity arrays have recently been found to increase the output power of nanocavity lasers by coherent coupling of a large number of cavities [1]. We have measured the sub-threshold behaviour of such structures in order to gain better understanding of the mode structure. PhC structures defined by circular holes placed in a quadratic lattice with pitch a=280 nm were fabricated in a GaAs membrane and cavity arrays were realized by introducing single missing holes with intracavity hole distances of two, three, five and seven holes. Arrays with different number of coupled cavities were fabricated and characterized using photoluminescence measurements of quantum dots embedded in the GaAs PhC membrane. Since the collection spot size was ~2.5 μm and therefore small compared to the arrays, spectra were taken at several positions of each array.

Time-resolved measurement of the light-current characteristic of a coated VCSEL diode in acetone vapour

Carrier dynamics and slow light in semiconductor nanostructures

General information
State: Published
Organisations: Department of Photonics Engineering, Quantum and Laser Photonics, Nanophotonic Devices
Contributors: Mørk, J., Öhman, F., Poel, M. V. D., Chen, Y., Xue, W., Hansen, P. L., Yvind, K.
Pages: CTuJ1
Publication date: 2008

Host publication information
Title of host publication: CLEO/QELS 2008
Place of publication: San Jose, CA, USA
Publisher: Optical Society of America OSA
Source: orbit
Source-ID: 233419
Research output: Research - peer-review › Article in proceedings – Annual report year: 2008

Distributed fiber Raman amplification in long reach PON bidirectional access links
Distributed Raman fiber amplification is proposed and experimentally demonstrated to support long reach passive optical network (PON) links. An 80 km, bidirectional, single fiber link is demonstrated using both standard intensity optical modulators at 10 Gb/s and up to 7.5 Gb/s using novel reflective semiconductor optical amplifier electro-absorption modulator.

General information
State: Published
Organisations: Metro-Access and Short Range Systems, Department of Photonics Engineering, Systems, Nanophotonics, Nanophotonic Devices
Contributors: Tafur Monroy, I., Kjær, R., Öhman, F., Yvind, K., Jeppesen, P.
Pages: 41-44
Publication date: 2008
Peer-reviewed: Yes

Publication information
Journal: Optical Fiber Technology
Volume: 14
Issue number: 1
ISSN (Print): 1068-5200
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 1.87 SJR 0.522 SNIP 0.955
Web of Science (2017): Impact factor 1.35
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.89 SJR 0.631 SNIP 1.11
Web of Science (2016): Impact factor 1.678
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 1.86 SJR 0.799 SNIP 1.163
Web of Science (2015): Impact factor 1.6
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Experimental observation of pulse delay and speed-up in cascaded quantum well gain and absorber media

Slow-down and speed-up of 180 fs pulses in semiconductor waveguides beyond the existing models is observed. Cascaded gain and absorbing sections is shown to provide significant temporal pulse shifting at near constant output pulse energy.

General information
Fabrication and measurements on coupled photonic crystal cavities
Quasi-three dimensional photonic crystals can be realized by fabricating thin membranes of high index material hanging in air patterned with sub-micron holes to create a photonic band gap for optical confinement in plane and total internal reflection for out of plane confinement. Introducing defects into the photonic crystal gives rise to defect states in the form of small confined modes. By embedding an active gain medium like quantum dots into the membrane makes it possible to realize lasers with ultra-small mode volumes and low thresholds. Unfortunately single cavity photonic crystal lasers have also a low output power. A promising way to increase the output power while keeping a low threshold is to couple a large number of cavities. We successfully fabricated several coupled cavity systems and measured on them in order to investigate the behaviour of the coupled systems and the interaction between coupled cavities depending on their relative coupling to each other.

Fabrication of Cantilevers by NIL

Laser self-mixing interferometry in VCSELs - an ultra-compact and massproducible deflection detection system for nanomechanical polymer cantilever sensors
We have realised an ultra-compact deflection detection system based on laser self-mixing interferometry in a Vertical-Cavity Surface-Emitting Laser (VCSEL). The system can be used together with polymer nanomechanical cantilevers to form chemical sensors capable of detecting less than 1nm deflection.
Low-noise monolithic mode-locked semiconductor lasers through low-dimensional structures

Nanophotonics: Semiconductor Optical Devices

Pulse delay and advancement of ultrafast pulses in semiconductor waveguides

Pulse Delay and Speed-up of Ultra Fast Pulses in an Absorbing Quantum Well Medium
Slow and fast light in semiconductor waveguides for applications in microwave photonics

General information
State: Published
Organisations: Department of Photonics Engineering, Quantum and Laser Photonics, Nanophotonic Devices
Contributors: Mørk, J., Öhman, F., Chen, Y., Poel, M. V. D., Yvind, K.
Publication date: 2008

Host publication information
Title of host publication: Photonics West
Place of publication: San Jose, USA
Publisher: SPIE - International Society for Optical Engineering
Source-ID: 233416
Research output: Research - peer-review › Article in proceedings – Annual report year: 2008

10 Gb/s-NRZ Optical 2R-regeneration in two-section SOA-EA chip
All optical 2R-regeneration based on the integration of semiconductor optical amplifiers and electroabsorbers in a single waveguide is experimentally demonstrated. Static transfer functions of concatenated structures show strong improvements of the nonlinearity. An extinction ratio improvement > 4.5 dB has been obtained under dynamics operation. For optical signal-to-noise ratio values above 17 dB, improvement in BER is observed. A receiver sensitivity improvement > 2 dB at BER of 10-9 was found for 10 Gb/s operation.

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonics
Contributors: Vivero, T., Calabretta, N., Tafur Monroy, I., Kassar, G., Öhman, F., Yvind, K., Gonzales-Marco, A., Mørk, J.
Pages: ThP2
Publication date: 2007

Host publication information
ISBN (Print): 978-1-4244-0925-9
Electronic versions:
Vivero.pdf
DOIs:
10.1109/LEOS.2007.4382653

Bibliographical note
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Source-ID: 210393
Research output: Research - peer-review › Article in proceedings – Annual report year: 2007

High-Power and Low-Noise 10-GHz All-Active Monolithic Mode-Locked Lasers with Surface Etched Bragg Grating
We have fabricated 4.4 mm long monolithic InAlGaAsP/InP mode-locked lasers with integrated deeply surface etched DBR-mirrors. The lasers produce 3.7 ps transform-limited Gaussian pulses with 10 mW average power and 250 fs timing jitter.
Long all-active monolithic mode-locked lasers with surface-etched bragg gratings

We have fabricated 4.4-mm-long monolithic InAlGaAsP–InP mode-locked lasers with integrated deeply surface etched distributed Bragg reflector (DBR) mirrors. The lasers produce 3.7-ps transform-limited Gaussian pulses with 10-mW average output power and 250-fs absolute timing jitter. The performance of the DBR lasers is compared to the performance of Fabry–Pérot mode-locked lasers from the same wafer and to the performance of earlier reported long monolithic DBR mode-locked lasers and is found to be better.
Long reach PON links for metro and access convergence

General information
State: Published
Organisations: Department of Photonics Engineering, Systems, Nanophotonics
Contributors: Tafur Monroy, I., Kjær, R., Seoane, J., Öhman, F., Yvind, K., Prince, K., Jeppesen, P.
Publication date: 2007

Host publication information
Title of host publication: APOC
Place of publication: Wuhan, China
Source: orbit
Source-ID: 209744
Research output: Research - peer-review › Article in proceedings – Annual report year: 2007

Monolithic mode-locked lasers with surface etched bragg gratings

General information
State: Published
Organisations: Nanophotonics, Department of Photonics Engineering
Contributors: Larsson, D., Yvind, K., Hvam, J. M.
Pages: CWA3
Publication date: 2007

Host publication information
Title of host publication: Conference on Lasers and Electro-Optics, Quantum Electronics and Laser Science Conference, Conference on Photonic Applications, Systems and Technologies
Source: orbit
Source-ID: 211504
Research output: Research - peer-review › Article in proceedings – Annual report year: 2007

Nanoteknologi i masseproduktion

General information
State: Published
Organisations: Nanophotonics, Department of Photonics Engineering
Contributors: Yvind, K., Larsson, D., Hansen, P. L.
Number of pages: 259
Pages: 51-62
Publication date: 2007

Host publication information
Title of host publication: Optiske Horisonter : en rejse på kommunikationsteknologiens vinger
Place of publication: Odense
Publisher: COM.DTU
Edition: 1
ISBN (Print): 87-92062-01-6
Source: orbit
Source-ID: 202152
Research output: Research - peer-review › Book chapter – Annual report year: 2007

Slow light in a semiconductor waveguide for true-time delay applications in microwave photonics
We have investigated the slow and fast light properties of a semiconductor waveguide device employing concatenated gain and absorber sections. This letter presents the experimental results as well as theoretical modeling. A large phase shift of 110 and a true-time delay of more than 150 ps are demonstrated. The combination of amplitude and phase control of the modulated signal shows great promise for applications within microwave photonics.

General information
State: Published
Slow light in semiconductor waveguides: theory and experiment

General information
State: Published
Organisations: Nanophotonics, Department of Photonics Engineering
Publication date: 2007
Peer-reviewed: Yes
Source: orbit
Source-ID: 202148
Research output: Research - peer-review » Conference abstract for conference – Annual report year: 2007

Slow light in semiconductor waveguides: Theory and experiment
Slow light in multi-section quantum well waveguide structure is realized using either coherent population oscillations (CPO) and electromagnetically induced transparency (EIT) is studied. The properties of the two schemes are compared and discussed.

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonics
Publication date: 2007

Host publication information
Publisher: IEEE
ISBN (Print): 978-1-4244-0931-0
Electronic versions:
Mark.pdf
DOIs:
10.1109/CLEOE-IQEC.2007.4386121

Bibliographical note
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Source: orbit
Source-ID: 209806
Research output: Research - peer-review » Article in proceedings – Annual report year: 2007

85 km Long Reach PON System Using a Reflective SOA-EA Modulator and Distributed Raman Fiber Amplification
We report on a bidirectional 85 km long reach PON system supported by distributed fiber Raman amplification with a record 7.5 Gb/s remote carrier modulated upstream signal by employing a reflective SOA-EA monolithically integrated circuit

General information
State: Published
Organisations: Metro-Access and Short Range Systems, Department of Photonics Engineering, Nanophotonic Devices, High-Speed Optical Communication
Contributors: Tafur Monroy, I., Ohman, F., Yvind, K., Kjær, R., Peucheret, C., Koonen, A., Jeppesen, P.
Pages: 705-706
Publication date: 2006

Host publication information
Title of host publication: IEEE Lasers & Electro-Optics Society
Publisher: IEEE
ISBN (Print): 0-7803-9555-7
Electronic versions:
Monroy.pdf
An in-situ monitoring technique for optimizing antireflection coatings using a monolithic integrated photodetector

A very low reflectivity of the order of $10^{-4}$ is demonstrated for dual-layer anti-reflection coatings on normal facet semiconductor lasers, by integrated in situ monitoring. The method has been tested on three and eight quantum-well InGaAsP ridge lasers that consist of a gain section and an integrated absorber section. The principle is to monitor the change in the photocurrent generated in the absorber that is proportional to the output optical intensity from the laser, which changes as the coating progresses.
Monolithically integrated reflective SOA-EA carrier re-modulator for broadband access nodes

General information
State: Published
Organisations: Systems, Department of Photonics Engineering, Nanophotonics
Contributors: Tafur Monroy, I., Öhman, F., Yvind, K., Christiansen, L., Mørk, J., Peucheret, C., Jeppesen, P.
Pages: 8060-8064
Publication date: 2006
Peer-reviewed: Yes

Publication information
Journal: Optical Express
Volume: 14
Issue number: 18
Original language: English
Source: orbit
Source-ID: 189884
Research output: Research - peer-review ; Journal article – Annual report year: 2006

Monolithic Hybrid and Passive Mode-Locked 40GHz Quantum Dot Laser Diodes
For the first time hybrid and passive mode-locking jitter performance is investigated in 40GHz quantum-dot mode-locked lasers. Record low passive mode-locking jitter of 219fs is presented, along with promising hybrid mode-locking results of 124fs.

General information
State: Published
Organisations: Nanophotonics, Department of Photonics Engineering, Center for Nanoteknologi, University of Cambridge, NL Nanosemiconductor GmbH
Slow Light at High Frequencies in an Amplifying Semiconductor Waveguide

We demonstrate slow-down of a modulated light signal in a semiconductor waveguide. Concatenated amplifying and absorbing sections simultaneously achieve both amplification and a controllable time delay at 15 GHz.

Steep and Adjustable Transfer Functions of Monolithic SOA-EA 2R-Regenerators

Measurements and numerical modeling of a reamplification and reshaping (2R) regenerator demonstrate a steep power transfer function with adjustable threshold. The threshold can be adjusted more than 6 dB by simple control of the reverse bias voltage of the absorber section. The device consists of a semiconductor waveguide with alternating amplifier and absorber sections using quantum-well active material. The steep nonlinearity of the transfer function is achieved by concatenating several sections. We identify the saturation properties of the absorbing media, as dictated by the band-filling and field screening, as important for the observed transfer functions. The relation of the saturation powers of the gain and absorption sections is important for design optimization.
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 2.84 SJR 0.961 SNIP 1.25
Web of Science (2017): Impact factor 2.446
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.52 SJR 0.989 SNIP 1.224
Web of Science (2016): Impact factor 2.375
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 2.62 SJR 1.19 SNIP 1.266
Web of Science (2015): Impact factor 1.945
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 2.78 SJR 1.421 SNIP 1.583
Web of Science (2014): Impact factor 2.11
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 2.95 SJR 1.495 SNIP 1.548
Web of Science (2013): Impact factor 2.176
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 2.46 SJR 1.647 SNIP 1.694
Web of Science (2012): Impact factor 2.038
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 2.48 SJR 1.539 SNIP 2.04
Web of Science (2011): Impact factor 2.191
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.457 SNIP 1.678
Web of Science (2010): Impact factor 1.989
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.721 SNIP 1.913
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.975 SNIP 1.864
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 2.224 SNIP 1.678
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 2.012 SNIP 1.869
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 2.882 SNIP 2.411
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 3.092 SNIP 2.689
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 3.17 SNIP 2.436
Voltage-controlled slow light in an integrated semiconductor structure with net gain

General information
State: Published
Organisations: Nanophotonics, Department of Photonics Engineering
Contributors: Öhman, F., Yvind, K., Mørk, J.
Pages: 9955-9962
Publication date: 2006
Peer-reviewed: Yes

Publication information
Journal: Optics Express
Volume: 14
Issue number: 21
ISSN (Print): 1094-4087
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.74 SJR 1.519 SNIP 1.567
Web of Science (2017): Impact factor 3.356
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.48 SJR 1.532 SNIP 1.544
Web of Science (2016): Impact factor 3.307
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 3.78 SJR 1.91 SNIP 1.674
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 4.18 SJR 2.313 SNIP 2.124
Web of Science (2014): Impact factor 3.488
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 4.38 SJR 2.337 SNIP 2.196
Web of Science (2013): Impact factor 3.525
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 3.85 SJR 2.562 SNIP 2.108
Web of Science (2012): Impact factor 3.546
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 4.04 SJR 2.58 SNIP 2.572
Web of Science (2011): Impact factor 3.587
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.906 SNIP 2.428
Web of Science (2010): Impact factor 3.753
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 3.039 SNIP 2.679
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 3.204 SNIP 2.423
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 3.284 SNIP 2.11
Web of Science (2007): Indexed yes
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 3.313 SNIP 2.336
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 2.819 SNIP 2.472
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 2.669 SNIP 2.217
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 1.745 SNIP 1.748
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 1.496 SNIP 1.42
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 0.98 SNIP 0.761
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 1.442 SNIP 0.843

Original language: English

Electronic versions:
2.pdf
DOIs:
10.1364/OE.14.009955
URLs:
http://www.opticsinfobase.org/oe/abstract.cfm?uri=oe-14-21-9955
Source: orbit
Source-ID: 194132
Research output: Research - peer-review › Journal article – Annual report year: 2006
Design and evaluation of modelocked semiconductor lasers for low noise and high stability

We present work on design of monolithic mode-locked semiconductor lasers with focus on the gain medium. The use of highly inverted quantum wells in a low-loss waveguide enables both low quantum noise, low-chirped pulses and a large stability region. Broadband noise measurements are performed and used to confirm the design principles.

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonics, Systems
Contributors: Yvind, K., Larsson, D., Christiansen, L. J., Oxenløwe, L. K., Mørk, J., Hvam, J. M., Hanberg, J.
Pages: 37-48
Publication date: 2005

Experimental Demonstration and Theoretical Analysis of Slow Light in a Semiconductor Waveguide at GHz Frequencies

Experimental demonstration and theoretical analysis of slow light in a semiconductor waveguide at GHz frequencies slow-down of light by a factor of two in a semiconductor waveguide at room temperature with a bandwidth of 16.7 GHz using the effect of coherent pulsations of the carrier density. The achievable delay is shown to be limited by the short lifetime. The maximum time delay observed reflects an approximately two-fold increase of the group refractive index, corresponding to a time delay of approximately 20 % of the carrier (population) lifetime. The experimental observations are well-explained by a model accounting for the absorption saturation in the waveguide, when using a lifetime that depends on the reverse bias.

General information
State: Published
Organisations: Nanophotonics, Department of Photonics Engineering, Systems
Contributors: Mørk, J., Kjær, R., Poel, M. V. D., Oxenløwe, L. K., Yvind, K.
Publication date: 2005

Light slow-down in semiconductor waveguides due to population pulsations

This study theoretically analyzes the prospect of inducing light-slow down in a semiconductor waveguide based on coherent population oscillation. Experimental observations of the effect are also presented.

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonics
Contributors: Mark, J., Kjaer, R., Poel, M. V. D., Yvind, K.
Pages: EA3-5-WED
Publication date: 2005
Measurement and Modeling of the Transfer Function of a Monolithic SOA-EA 2R-Regenerator
We have measured steep power transfer characteristics with tunable threshold for a monolithic 2R-regenerator combining amplifying and absorbing sections. Modeling results explain the basic characteristics.

Measurement of record-low residual jitter in 40-GHz monolithic mode-locked lasers
We have performed residual phase-noise measurements on 40-GHz mode-locked lasers. The intrinsic jitter of lasers with 1, 2 and 3 QWs is compared and a minimum of 39 fs is found for the 1-QW device.
Measurements of record-low residual jitter in 40-GHz monolithic mode-locked lasers

We have performed residual phase-noise measurements on 40-GHz mode-locked lasers. The intrinsic jitter of lasers with 1, 2 and 3 QWs is compared and a minimum of 39 fs is found for the 1-QW device.

Mode-Locked Semiconductor Lasers for Optical Communication Systems

We present investigations on 10 and 40 GHz monolithic mode-locked lasers for applications in optical communication systems. New all-active lasers with one to three quantum wells have been designed, fabricated and characterized.

Mode-locked semiconductor lasers with low noise and high stability

We have performed residual phase-noise measurements on 40-GHz mode-locked lasers. The intrinsic jitter of lasers with 1, 2 and 3 QWs is compared and a minimum of 39 fs is found for the 1-QW device.
Monolithic mode-locked lasers with deeply dry etched Bragg mirror

Background: Semiconductor mode-locked lasers are attractive as components in future ultra-high-speed telecommunication systems (160-640 Gb/s); as picosecond pulse sources, clock-recovery devices and for demultiplexing in Optical Time Division Multiplexing (OTDM) systems. We have recently designed, fabricated and characterized monolithic mode-locked lasers with record-low timing instabilities (jitter) and high optical power. However, these lasers were of the Fabry-Perot type and the optical spectrum is influenced by the biasing of the gain and absorber sections and also by the carrier dynamics in the gain section, such as self-phase modulation. The solution to this problem is to integrate the laser with a wavelength selective Bragg grating. Another advantage of the gratings should be lower noise. Deep Reactive Ion Etching (RIE) of the grating is a key for low-cost mass production of these lasers, making it possible to buy epitaxial wafers from photonic foundries as in the microelectronic industry.

Design: The reflectivity spectrum from the total grating is calculated by matrix multiplication of the individual periodic grating elements. The period of the grating, given by the mean effective index of the low and high index regions (etched and unetched), is 240 nm for a 1st order grating and 480 nm for the 2nd order. Fabrication: The mask for the grating is formed by a combination of E-beam writing and UV-lithography. The resist pattern is transferred to a 100 nm SiO2-film, with a CHF3 (Freon) based dry etch. The SiO2-film functions as a mask in the subsequent RIE of the semiconductor (InP). We are now optimizing the semiconductor RIE to achieve 2 µm deep waveguides and gratings with smooth vertical sidewalls and smooth bottom surface. This optimization involves optimizing the reaction chamber parameters: CH4/H2 gas mixture, gas flow, chamber pressure and the power supplied to the plasma. Figure 1: SEM micrograph of a deeply etched 2nd order grating and waveguide in InP. K. Yvind et al, Phot. Technology Letters 16, 975-977 (2004) Y. Feurprier et al., J. Vac. Sci. A 16(3), 1552-1559 (1998)

General information
State: Published
Organisations: Nanophotonics, Department of Photonics Engineering
Contributors: Larsson, D., Yvind, K., Hvam, J. M.
Publication date: 2005
Peer-reviewed: No
Source: orbit
Source-ID: 184445
Research output: Research › Poster – Annual report year: 2005

Nonlinear saturation dynamics and its application to all-optical regeneration and light slow-down

General information
State: Published
Organisations: Department of Photonics Engineering
Contributors: Mørk, J., Öhman, F., Kjær, R., Yvind, K.
Publication date: 2005
Peer-reviewed: No
Event: Abstract from Workshop on Nonlinear Dynamics in Photonics, Berlin, Germany.
Source: orbit
Source-ID: 186456
Research output: Research › Conference abstract for conference – Annual report year: 2005

Slow light in a semiconductor waveguide at gigahertz frequencies

We experimentally demonstrate slow-down of light by a factor of three in a 100 µm long semiconductor waveguide at room temperature and at a record-high frequency of 16.7 GHz. It is shown that the group velocity can be controlled all-optically as well as through an applied bias voltage. A semi-analytical model based on the effect of coherent population oscillations and taking into account propagation effects is derived and is shown to well account for the experimental results. It is shown that the carrier lifetime limits the maximum achievable delay. Based on the general model we analyze fundamental limitations in the application of light slowdown due to coherent population oscillations.

General information
State: Published
Organisations: Nanophotonics, Department of Photonics Engineering, Systems
Contributors: Mørk, J., Kjær, R., Poel, M. V. D., Yvind, K.
Pages: 8136
Publication date: 2005
Peer-reviewed: Yes
Wide-band residual phase-noise measurements on 40-GHz monolithic mode-locked lasers
We have performed wide-band residual phase-noise measurements on semiconductor 40-GHz mode-locked lasers by employing electrical waveguide components for the radio-frequency circuit. The intrinsic timing jitters of lasers with one, two, and three quantum wells (QW) are compared and our design prediction, concerning noise versus number of QWs, for the first time corroborated by experiments. A minimum jitter of 44 fs is found, by extrapolating to the Nyquist frequency, for the one-QW device having nearly transform-limited pulses of 1.2 ps. This jitter is nearly three times lower than for a three-QW laser. There is good agreement between the measured results and existing theory.

General information
State: Published
Organisations: Nanophotonics, Department of Photonics Engineering
Contributors: Larsson, D., Yvind, K. (ed.), Hvam, J. M.
Pages: 2388-2390
Publication date: 2005
Peer-reviewed: Yes

Publication information
Journal: IEEE Photonics Technology Letters
Volume: 17
Issue number: 11
ISSN (Print): 1041-1135
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 2.84 SJR 0.961 SNIP 1.25
Web of Science (2017): Impact factor 2.446
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.52 SJR 0.989 SNIP 1.224
Web of Science (2016): Impact factor 2.375
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 2.62 SJR 1.19 SNIP 1.266
Web of Science (2015): Impact factor 1.945
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
106 to 10 Gb/s all-optical demultiplexing using a single electroabsorption modulator

General information
State: Published
Organisations: Systems, Department of Photonics Engineering, Optoelectronics
Contributors: Xu, L., Chi, N., Christiansen, L. J., Yvind, K., Oxenløwe, L. K., Mørk, J., Jeppesen, P.
Publication date: 2004

Host publication information
Title of host publication: Proceedings of ECOC 2004
Volume: Paper We1.5.3
Place of publication: Sweden
Source: orbit
Source-ID: 155661
Research output: Research - peer-review › Article in proceedings – Annual report year: 2004

2R Regeneration in Concatenated Semiconductor Optical Amplifiers and Electroabsorbers
We present a novel 2R regenerator with a large level separation and steep step a sharp, adjustable threshold based on concatenated semiconductor optical amplifiers and electroabsorbers. We demonstrate demonstrate improvements in both extinction-ratio and BER sensitivity atfor a 10 Gb/s NRZ signal.

General information
State: Published
Organisations: Department of Photonics Engineering
Contributors: Christiansen, L. J., Xu, L., Yvind, K., Öhman, F., Oxenløwe, L. K., Mørk, J.
Pages: 30-31
Publication date: 2004

Host publication information
Title of host publication: ECOC 2004 Proceedings
Volume: 1
ISBN (Print): 91-97-52911-7
Source: orbit
Source-ID: 61230
Research output: Research - peer-review › Article in proceedings – Annual report year: 2004

7x40 Gb/s base rate RZ all-optical broadcasting utilizing an electroabsorption modulator

General information
State: Published
Organisations: Systems, Department of Photonics Engineering, Optoelectronics
Contributors: Xu, L., Chi, N., Yvind, K., Christiansen, L. J., Oxenløwe, L. K., Mørk, J., Jeppesen, P.
Pages: 416-420
Publication date: 2004
Peer-reviewed: Yes

Publication information
Journal: Optics Express
Volume: 12
Issue number: 3
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.74 SJR 1.519 SNIP 1.567
Web of Science (2017): Impact factor 3.56
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.48 SJR 1.532 SNIP 1.544
Web of Science (2016): Impact factor 3.307
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 3.78 SJR 1.91 SNIP 1.674
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 4.18 SJR 2.313 SNIP 2.124
Web of Science (2014): Impact factor 3.488
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 4.38 SJR 2.337 SNIP 2.196
Web of Science (2013): Impact factor 3.525
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 3.85 SJR 2.562 SNIP 2.108
Web of Science (2012): Impact factor 3.546
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 4.04 SJR 2.58 SNIP 2.572
Web of Science (2011): Impact factor 3.587
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.906 SNIP 2.428
Web of Science (2010): Impact factor 3.753
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 3.039 SNIP 2.679
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 3.204 SNIP 2.423
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 3.284 SNIP 2.11
Web of Science (2007): Indexed yes
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 3.313 SNIP 2.336
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 2.819 SNIP 2.472
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 2.669 SNIP 2.217
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 1.745 SNIP 1.748
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 1.496 SNIP 1.42
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 0.98 SNIP 0.761
8x40 Gb/s RZ all-optical broadcasting utilizing an electroabsorption modulator

We experimentally demonstrate all-optical broadcasting through simultaneous 8 × 40 Gb/s wavelength conversion in the RZ format based on cross absorption modulation in an electroabsorption modulator. The original intensity-modulated information is successfully duplicated onto eight wavelengths that comply with the ITU-T proposal. The advantages of the proposed wavelength conversion scheme are discussed.

General information
State: Published
Organisations: Systems, Department of Photonics Engineering, Optoelectronics
Pages: MF71
Publication date: 2004

Host publication information
Title of host publication: Technical Digest Optical Fiber Communication Conference 2004
Place of publication: USA
Publisher: IEEE
Electronic versions:
Xu.pdf
DOIs:
10.1109/OFC.2004.1359236

Bibliographical note
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Source: orbit
Source-ID: 155659
Research output: Research - peer-review › Article in proceedings – Annual report year: 2004

Experimental characterisation of a highly non-linear fibre based 3-stage NOLM scheme for regeneration at 160 Gb/s

High-performance 10 GHz all-active monolithic mode-locked semiconductor lasers

Using a novel design strategy for the epitaxial structure for monolithic modelocked semiconductor lasers, lasers capable of producing <2 ps pulses at 10 GHz with very low high-frequency jitter have been fabricated in a single growth step.

General information
State: Published
Organisations: Department of Photonics Engineering
Pages: 735-736
Low-jitter and high-power 40 GHz all-active mode-locked lasers
A novel design strategy for the epitaxial structure of monolithic mode-locked semiconductor lasers is presented. Using an all-active design, we fabricate 40-GHz lasers generating 2.8-ps almost chirp-free pulses with record low high-frequency jitter and more than 7-mW fiber coupled output power.

General information
State: Published
Organisations: Department of Photonics Engineering
Pages: 975-977
Publication date: 2004
Peer-reviewed: Yes

Publication information
Journal: IEEE Photonics Technology Letters
Volume: 16
Issue number: 4
ISSN (Print): 1041-1135
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 2.84 SJR 0.961 SNIP 1.25
Web of Science (2017): Impact factor 2.446
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.52 SJR 0.989 SNIP 1.224
Web of Science (2016): Impact factor 2.375
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 2.62 SJR 1.19 SNIP 1.266
Web of Science (2015): Impact factor 1.945
Web of Science (2015): Indexed yes
Low-jitter prescaled clock recovery with compact semiconductor components for ultra high-speed OTDM systems

General information
State: Published
Organisations: Systems, Department of Photonics Engineering, Optoelectronics, Networks
Contributors: Oxenløwe, L. K., Christiansen, L. J., Larsson, D., Yvind, K., Clausen, A., Seoane, J., Siahlo, A., Sørensen, B. M., Jeppesen, P.
Pages: 888-889
Publication date: 2004

Host publication information
Title of host publication: OECC 2004
Volume: Paper 16E3-5
Place of publication: Japan
Source: orbit
Source-ID: 154916
Research output: Research - peer-review › Article in proceedings – Annual report year: 2004

Novel design of low-jitter 10 GHz all-active monolithic mode-locked lasers
Using a novel design, we have fabricated 10 GHz all-active monolithic mode-locked semiconductor lasers that generate 1.4 ps pulses with record-low timing jitter. The dynamical properties of lasers with 1 and 2 QWs are compared.

General information
State: Published
Organisations: Department of Photonics Engineering
Publication date: 2004

Host publication information
Title of host publication: 2004 CLEO/IQEC Technical Digest CD-Rom
Publisher: IEEE
ISBN (Print): 15-57-52770-9
Electronic versions:
Larsson.pdf
DOIs:
10.1109/CLEO.2004.1360941

Bibliographical note
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Source: orbit
Source-ID: 61264
Research output: Research - peer-review › Article in proceedings – Annual report year: 2004

Optical label switching in telecommunication using semiconductor lasers, amplifiers and electro-absorption modulators
We demonstrate all-optical label encoding and updating for an orthogonally labeled signal in combined IM/FSK modulation format utilizing semiconductor lasers, semiconductor optical amplifiers and electro-absorption modulators. Complete functionality of a network node including two-hop transmission and all-optical label swapping is also experimentally demonstrated with overall penalty of less than 2 dB, proving the orthogonal IM/FSK labeling scheme to be a feasible solution for future optically labeled networks.

General information
State: Published
Organisations: Department of Photonics Engineering, High-Speed Optical Communication, Nanophotonic Devices, Metro-Access and Short Range Systems, Technical University of Denmark
Pages: 144-152
Publication date: 2004
Pre-Scaled clock recovery with compact semiconductor devices for ultra high-speed OTDM systems

General information
State: Published
Organisations: Systems, Department of Photonics Engineering, Optoelectronics, Networks
Contributors: Oxenløwe, L. K., Christiansen, L. J., Larsson, D., Yvind, K., Clausen, A., Seoane, J., Siahlo, A., Sørensen, B. M., Jeppesen, P.
Publication date: 2004

Host publication information
Title of host publication: Proc. SPIE 5480 : Laser Optics: Diode Lasers and Telecommunication Systems
Volume: 144
Publisher: SPIE - International Society for Optical Engineering
Source: orbit
Source-ID: 314637
Research output: Research - peer-review › Article in proceedings – Annual report year: 2003

Ultralow noise monolithic mode-locked semiconductor lasers

General information
State: Published
Organisations: Department of Photonics Engineering
Publication date: 2004
Peer-reviewed: No
Event: Poster session presented at DTU International Nanosymposium, Kgs. Lyngby, Denmark.
URLs:
Source: orbit
Source-ID: 61350
Research output: Research › Poster – Annual report year: 2004

10 GHz All-Active Monolithic Mode-Locked Lasers

General information
State: Published
Organisations: Optoelectronics, Department of Photonics Engineering, Systems
Publication date: 2003
Peer-reviewed: No
Source: orbit
Source-ID: 23441
Research output: Research › Paper – Annual report year: 2003

A novel 160 Gb/s receiver configuration including a glass crystal pulsed laser, photonic crystal fiber and a simple dynamic clock recovery scheme: Scoop

General information
State: Published
Organisations: Systems, Department of Photonics Engineering, Networks, Glass Components and Materials, Department of Micro- and Nanotechnology
Experimental demonstration of cascaded transmission and al-optical label swapping of orthogonal IM/(FSK labelled signal

General information
State: Published
Organisations: Systems, Department of Photonics Engineering, Optoelectronics
Contributors: Chi, N., Zhang, J., Holm-Nielsen, P. V., Xu, L., Monroy, I. T., Peucheret, C., Yvind, K., Christiansen, L. J., Jeppesen, P.
Pages: 676-678
Publication date: 2003
Peer-reviewed: Yes

Publication information
Journal: Electronics Letters
Volume: 39
Issue number: 8
ISSN (Print): 0013-5194
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 1.55 SJR 0.407 SNIP 0.906
Web of Science (2017): Impact factor 1.232
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.35 SJR 0.402 SNIP 0.86
Web of Science (2016): Impact factor 1.155
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 1.31 SJR 0.47 SNIP 0.959
Web of Science (2015): Impact factor 0.854
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 1.31 SJR 0.5 SNIP 1.024
Web of Science (2014): Impact factor 0.93
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 1.45 SJR 0.544 SNIP 1.108
Web of Science (2013): Impact factor 1.068
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 1.45 SJR 0.588 SNIP 1.12
Web of Science (2012): Impact factor 1.038
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Experimental demonstration of cascaded transmission and all-optical label swapping of orthogonal IM/FSK labelled signal

A network node is demonstrated with two-hop transmission and all-optical label swapping. It is based on a Mach-Zehnder semiconductor optical amplifier interferometer and electroabsorption modulator of a two-level optically labelled signal using an orthogonal IM/FSK modulation format with an overall power penalty of less than 2 dB.

General information
State: Published
Organisations: Department of Photonics Engineering, Metro-Access and Short Range Systems, High-Speed Optical Communication, Nanophotonic Devices
Pages: 676 - 678
Publication date: 2003
Peer-reviewed: Yes

Publication information
Journal: Electronics Letters
Volume: 39
Issue number: 8
ISSN (Print): 0013-5194
Ratings:
BFI (2019): BFI-level 1
Low jitter and high power all-active mode-locked lasers
A novel epitaxial design leading to low loss and low gain saturation improves the properties of 40 GHz mode-locked lasers. We obtain 2.8 ps nearly chirp free pulses with 228 fs jitter and fiber-coupled power of 7 mW.

General information
State: Published
Organisations: Department of Photonics Engineering
Pages: 320-321
Publication date: 2003

Host publication information
Title of host publication: ECOC-IOOC 2003 Proceedings
Source: orbit
Source-ID: 189011
Research output: Research - peer-review » Conference abstract in proceedings – Annual report year: 2003

Low jitter and high power all-active mode-locked lasers
A novel epitaxial design leading to low loss and low gain saturation improves the properties of 40 GHz mode-locked lasers. We obtain 2.8 ps nearly chirp free pulses with 228 fs jitter and fiber-coupled power of 7 mW.

General information
State: Published
Organisations: Optoelectronics, Department of Photonics Engineering, Systems
Pages: 320-321
Publication date: 2003

Host publication information
Title of host publication: ECOC-IOOC 2003 Proceedings
Volume: 2
Source: orbit
Source-ID: 23358
Research output: Research - peer-review » Article in proceedings – Annual report year: 2003

Optical label encoding using electroabsorption modulators and investigation of chirp properties
A novel scheme of optical label encoding by wavelength conversion based on electroabsorption modulators (EAMs) is reported. Based on the experimental observations, the chirp properties of the wavelength-converted signal are discussed and a wide dynamic range of the chirp α-parameter is found allowed. Compared with cross-gain modulation (XGM) in a
semiconductor optical amplifier (SOA), the EAM has several advantages, which make it attractive for optical label encoding or other applications as a wavelength converter.
Optical label swapping and packet transmission based on ASK/DPSK orthogonal modulation format in IP-over-WDM networks

We demonstrate all-optical label swapping based on SOA, EAM and HNLF for a two-level optically labeled packet using orthogonal ASK/DPSK modulation format. The ASK/DPSK packet is successfully transmitted over 80 km NZDSF.
Optical signal processing using electro-absorption modulators: (invited)
Reverse-biased semiconductor waveguides are efficient saturable absorbers and have a number of promising all-optical signal processing applications. Results on ultrafast modulator dynamics as well as demonstrations and investigations of wavelength conversion and regeneration are presented.

Semiconductor Mode-Locked Lasers for Optical Communication Systems
The thesis deals with the design and fabrication of semiconductor mode-locked lasers for use in optical communication systems. The properties of pulse sources and characterization methods are described as well as requirements for application in communication systems. Especially, the importance of, and ways to reduce high-frequency jitter is discussed. The main result of the thesis is a new design of the epitaxial structure that both enables simplified fabrication and improves the properties of monolithic lasers. 40 GHz monolithic lasers with record low jitter and high power is presented as well as the first 10 GHz all-active monolithic laser with both short pulses and low jitter. Results from external cavity mode-locked lasers are also reported along with an investigation of the influence of the operating conditions on the performance of the device. Antireflection coatings are a critical limiting factor for external cavity devices and a chapter is devoted to calculations on coating design. The fabrication process for the lasers is outlined and solutions to the challenges encountered in realizing the proposed structures are reported.
An Ultra Low Noise Self-Starting Pulse Generator

We describe a self-starting optical pulse source generating 10 GHz, 15 ps pulses with an average jitter of 43 fs and a 0.15% amplitude noise over a frequency range of 500 Hz - 1 MHz.

General information
State: Published
Organisations: Optoelectronics, Department of Photonics Engineering, Technion-Israel Institute of Technology
Publication date: 2002

A self-starting hybrid optoelectronic oscillator generating ultra low jitter 10-GHz optical pulses and low phase noise electrical signals

In this letter, we describe a self-starting optical pulse source generating ultra low noise 15-ps-wide pulses at 10 GHz. It is based on a hybrid optoelectronic oscillator comprising a fiber extended cavity mode-locked diode laser which injection locks a self-oscillating heterojunction bipolar phototransistor. Average jitter levels of 40-43 fs and an amplitude noise of 0.1-0.15% over a frequency range of 500 Hz-15 kHz or 500 Hz-1 MHz were obtained, respectively. The noise is slightly larger, a 57- fs jitter and 0.2% amplitude noise, for a frequency range of 100 Hz-1 MHz. A 10-GHz electrical signal with a low phase noise (-108 dBC/Hz at 10-kHz offset from the carrier) is also generated.

General information
State: Published
Organisations: Optoelectronics, Department of Photonics Engineering
Pages: 1004-1006
Publication date: 2002
Peer-reviewed: Yes
Bandwidth and chirp characterisation of wavelength conversion based on electroabsorption modulators

It is demonstrated experimentally that the frequency chirp of a data modulated signal can be reduced and the modulation bandwidth increased through wavelength conversion in an electroabsorption modulator.

General information
State: Published
Organisations: Systems, Department of Photonics Engineering, Optoelectronics, Department of Micro- and Nanotechnology
Pages: 1-2
Publication date: 2002

Host publication information
Volume: 3
Place of publication: Denmark
Publisher: IEEE
ISBN (Print): 87-90974-63-8
Electronic versions: Xu.pdf

Bibliographical note
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Source: orbit
Source-ID: 153989
Research output: Research - peer-review › Article in proceedings – Annual report year: 2002

Improved electroabsorption demultiplexer by tandem-arrangement with semiconductor optical amplifier

An electroabsorption demultiplexer was improved by operating it in a tandem-arrangement with an optically controlled SOA. An increase of the maximum data rate from 40 Gbit/s to 80 Gbit/s was experimentally demonstrated. The main drawback of the proposed scheme is the need of an additional optical control. In this experiment a mode locked laser was used to control the SOA. However, it should be sufficient to use a gain-switched DFB-laser. The advantage of this scheme is that no electronic devices for frequencies higher than 10 GHz are required and no additional RF-source or RF-amplifier is needed for the control laser. The set-up is very robust, especially because it does not base on interferometric or polarization sensitive effects.

General information
State: Published
Organisations: Optoelectronics, Department of Photonics Engineering
Pages: 742-743
Publication date: 2002

Host publication information
Title of host publication: Technical Digest, Optical Fiber Communication Conference and Exhibit, 2002
Publisher: Opt Soc. America
ISBN (Print): 15-57-52701-6
Source: orbit
Source-ID: 42890
Research output: Research - peer-review › Article in proceedings – Annual report year: 2002

Performance of external cavity mode-locked semiconductor lasers employing reverse biased saturable absorbers

We have experimentally investigated the performance of external cavity mode-locked semiconductor lasers employing reverse biased saturable absorbers. We have measured the magnitude of trailing pulses when varying the chip length and studied the pulse quality when changing the driving conditions. The observed behavior is explained and we conclude on the optimum operating parameters.

General information
Short pulse absorption dynamics in a p-i-n InGaAsP MQW waveguide saturable absorber
The saturation properties and absorption dynamics of an InGaAsP MQW waveguide saturable absorber is measured using short 200-fs and 1-ps pulses. The dependence on the pulse energy and reverse bias is characterized.

Tunable mode-locked semiconductor laser with Bragg mirror external cavity
We present a simplified design for a wavelength tunable external cavity mode-locked laser by employing a wedged GaAs/AlGaAs Bragg mirror. The device emits 4-6 ps pulses at 10 GHz and is tunable over 15 nm. Although, in the present configuration, tunability is limited to 15 nm, however, we have shown the potential of a tuning range above 100 nm in a single mechanical stable device.

All-optical demultiplexing and wavelength conversion in an electroabsorption modulator
Cross-absorption modulation in an all electroabsorption modulator is utilised to perform 80/10 Gb/s all-optical demultiplexing. An improvement in receiver sensitivity at 10 Gb/s is demonstrated when wavelength converting.
Characterisation of a MQW electroabsorption modulator as an all-optical demultiplexer

A detailed experimental investigation of the all-optical switching properties of an InGaAsP MQW electroabsorption modulator has been performed. Using high pump pulse energies and high reverse bias settings, switching windows were demonstrated with extinction ratios up to 25 dB and widths down to 10 ps, possibly facilitating 100/10 Gb/s demultiplexing.

Performance of an External Cavity Mode-locked Semiconductor Laser using Reverse Biased Saturable Absorber

A detailed experimental investigation of the all-optical switching properties of an InGaAsP MQW electroabsorption modulator has been performed. Using high pump pulse energies and high reverse bias settings, switching windows were demonstrated with extinction ratios up to 25 dB and widths down to 10 ps, possibly facilitating 100/10 Gb/s demultiplexing.
SCOOP - Semiconductor COmponents for Optical signal Processing

Opto-electronic semiconductor devices operating at very high bitrates play a central role in the continued expansion of the transmission capacity of optical communication systems. A number of different devices based on quantum well structures have been manufactured within the framework of the national SCOOP programme. Results for a high-speed modulator, a short-pulse laser and an all-optical switch are presented.

General information
State: Published
Organisations: Optoelectronics, Department of Photonics Engineering, Systems, GIGA A/S
Pages: 25-30
Publication date: 2001
Peer-reviewed: Unknown

Publication information
Journal: DOPS-Nyt
Volume: 16
Issue number: 2
ISSN (Print): 0901-4632
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Original language: English
Source: orbit
Source-ID: 42963
Research output: Communication › Journal article – Annual report year: 2001

The cascaded amplifier and saturable absorber (CASA) all-optical switch

The cascaded amplifier and saturable absorber is presented as a new all-optical switching scheme for optical signal processing applications. First demultiplexing experiments demonstrate the principle of operation of this scheme.

General information
State: Published
Organisations: Optoelectronics, Department of Photonics Engineering, Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute, HHI, GIGA A/S
Pages: 39-41
Publication date: 2001

Host publication information
Title of host publication: Technical Digest Photonics in Switching
Source: orbit
Source-ID: 42976
Research output: Research - peer-review › Article in proceedings – Annual report year: 2001

Projects:

Foundry based silicon photonics devices
Alam, A. S., PhD Student, Department of Photonics Engineering
Yvind, K., Main Supervisor
Frandsen, L. H., Supervisor
Galili, M., Supervisor
01/09/2018 → 31/08/2021
Project: PhD
Nonlinear Integrated Photonics
Kim, C., PhD Student, Department of Photonics Engineering
Pu, M., Main Supervisor
Yvind, K., Supervisor
Grundforskningsfonden
01/01/2018 → 31/12/2020
Award relations: Nonlinear Integrated Photonics
Project: PhD

Fabrication and characterization of novel nanophotonic structures with electrical control
Marchevsky, A., PhD Student, Department of Photonics Engineering
Yvind, K., Main Supervisor
Merk, J., Supervisor
Ottaviano, L., Supervisor
Samfinansierede - Virksomhed
01/10/2016 → 30/09/2019
Award relations: Fabrication and characterization of novel nanophotonic structures with electrical control
Project: PhD

VCSEL’s til medicinsk diagnosticering
Ansbaek, T., PhD Student, Department of Photonics Engineering
Yvind, K., Main Supervisor
Chung, I., Supervisor
Larsson, D., Supervisor
Hvam, J. M., Examiner
Amann, M. C., Examiner
Birkedal, D., Examiner
Technical University of Denmark
01/11/2008 → 20/09/2012
Award relations: VCSEL’s til medicinsk diagnosticering
Project: PhD

Photonic Crystal Fano Lasers
Mathiesen, K. S., PhD Student, Department of Photonics Engineering
Merk, J., Main Supervisor
Yvind, K., Supervisor
Samfinansierede - Virksomhed
01/09/2016 → 31/08/2019
Award relations: Photonic Crystal Fano Lasers
Project: PhD

Nonlinear integrated photonics
Stassen, E., PhD Student, Department of Photonics Engineering
Yvind, K., Main Supervisor
Galili, M., Supervisor
Pu, M., Supervisor
Frandsen, L. H., Examiner
Kuyken, B., Examiner
Sciancalepore, C., Examiner
Grundforskningsfonden
01/02/2016 → 01/05/2019
Award relations: Nonlinear integrated photonics
Project: PhD

Tailored nanoscale optical materials and devices
Sakanas, A., PhD Student, Department of Photonics Engineering
Yvind, K., Main Supervisor
Merk, J., Supervisor
Semenova, E., Supervisor
Stobbe, S., Examiner
Moselund, K. E., Examiner
Reithmaier, J. P., Examiner
Samfinansierede - Virksomhed
01/08/2015 → 31/01/2019
Award relations: Tailored nanoscale optical materials and devices
Project: PhD

**Photonic crystal Fano structures**
Bekele, D. A., PhD Student, Department of Photonics Engineering
Mark, J., Main Supervisor
Ottaviano, L., Supervisor
Yvind, K., Supervisor
Frandsen, L. H., Examiner
De Rossi, A., Examiner
O'Faolain, L., Examiner
Samfinansieret - Andet
15/05/2015 → 30/09/2018
Award relations: Photonic crystal Fano structures
Project: PhD

Developing of Superior Quantum Dot Gain Material for 1.5-1.6 um Wavelenght Range
Shikin, A., PhD Student, Department of Photonics Engineering
Semenova, E., Main Supervisor
Almdal, K., Supervisor
Yvind, K., Supervisor
Malureanu, R., Examiner
Zhukov, A. E., Examiner
Posselt, D., Examiner
Eksternt finansieret virksomhed
15/03/2015 → 15/06/2018
Award relations: Developing of Superior Quantum Dot Gain Material for 1.5-1.6 um Wavelenght Range
Project: PhD

Ice lithography for large-scale sub-10 nm patterning
Tiddi, W., PhD Student, Department of Physics
Beleggia, M., Main Supervisor
Han, A., Supervisor
Yvind, K., Examiner
Hagen, C. W. K., Examiner
Nouverté, F., Examiner
Technical University of Denmark
15/12/2014 → 16/05/2018
Award relations: Ice lithography for large-scale sub-10 nm patterning
Project: PhD

MEMS Tunable VCSEKs for Optical Coherence Tomography
Sahoo, H. K., PhD Student, Department of Photonics Engineering
Yvind, K., Main Supervisor
Ansbæk, T., Supervisor
Hansen, O., Supervisor
Thomsen, E. V., Examiner
Birkedal, D., Examiner
Küppers, F., Examiner
Offentlig finansiering
01/10/2014 → 05/04/2018
Award relations: MEMS Tunable VCSEKs for Optical Coherence Tomography
Project: PhD

Developing of III-V epitaxy of highly efficient quantum dot gain material to the silicon platform
Viazmitinov, D., PhD Student, Department of Photonics Engineering
Semenova, E., Main Supervisor
Frandsen, L. H., Supervisor
Yvind, K., Supervisor
Hansen, O., Examiner
Hannappel, T., Examiner
Tchernycheva, M., Examiner
Eksternt finansieret virksomhed
01/10/2014 → 30/06/2018
Award relations: Developing of III-V epitaxy of highly efficient quantum dot gain material to the silicon platform
Project: PhD

Design and fabrication of mid-infrared plasmonic materials based on highly doped III-V semiconductors
Panah, M. E. A., PhD Student, Department of Photonics Engineering
Laurynenkna, A., Main Supervisor
Semenova, E., Supervisor
Yvind, K., Examiner
Engheta, N., Examiner
Bordo, V. G., Examiner
Technical University of Denmark
15/02/2014 → 23/08/2017
Award relations: Design and fabrication of mid-infrared plasmonic materials based on highly doped III-V semiconductors
Project: PhD

Advanced Characterization of One-dimensional Nanowires for Photovoltaics by Electron Microscopy
Persson, J. M., PhD Student, Department of Physics
Wagner, J. B., Main Supervisor
Dunin-Borkowski, R. E., Supervisor
Yvind, K., Examiner
van Helvoort, A. T. J., Examiner
Johnson, E., Examiner
Anden EU-finansiering
01/05/2009 → 19/12/2012
Award relations: Advanced Characterization of One-dimensional Nanowires for Photovoltaics by Electron Microscopy
Project: PhD

MEMS Optical Sensor Systems
Reck-Nielsen, K., PhD Student, Department of Micro- and Nanotechnology
Hansen, O., Main Supervisor
Thomsen, E. V., Supervisor
Yvind, K., Examiner
Bouwstra, S., Examiner
Müllenborn, M., Examiner
Offentlig finansiering
01/09/2008 → 14/12/2011
Award relations: MEMS Optical Sensor Systems
Project: PhD

Ultrafast nonlinear dynamics in semiconductor nanostructures
Porte, H. P., PhD Student, Department of Photonics Engineering
Jepsen, P. U., Main Supervisor
Turchinovich, D., Supervisor
Yvind, K., Examiner
Kuzel, P., Examiner
Nygaard, J., Examiner
Offentlig finansiering
01/05/2008 → 24/08/2011
Award relations: Ultrafast nonlinear dynamics in semiconductor nanostructures
Project: PhD

Characterization of pulse propagation in photonic crystal structures and ultrafast dynamics in quantum dots
Ek, S., PhD Student, Department of Photonics Engineering
Mørk, J., Main Supervisor
Hansen, P. L., Supervisor
Yvind, K., Supervisor
Oxenløwe, L. K., Examiner
Albrektsen, O., Examiner
Dorren, H. J. S., Examiner
Eksternt finansieret virksomhed
01/11/2008 → 22/06/2012
Award relations: Characterization of pulse propagation in photonic crystal structures and ultrafast dynamics in quantum dots
Project: PhD

**Femtosecond semiconductor lasers**
Kulkova, I., PhD Student, Department of Photonics Engineering
Yvind, K., Main Supervisor
Larsson, D., Supervisor
Semenova, E., Supervisor
Tafur Monroy, I., Examiner
Avrutin, E., Examiner
Decobert, J., Examiner
Institut/centerfinansieret
01/08/2010 → 24/09/2014
Award relations: Femtosecond semiconductor lasers
Project: PhD

**Nanoscale semiconductor optical devices**
Kuznetsova, N., PhD Student, Department of Photonics Engineering
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Semenova, E., Supervisor
Malureanu, R., Examiner
Kardynal, B., Examiner
Cirlin, G., Examiner
Institut/centerfinansieret
01/09/2010 → 18/06/2015
Award relations: Nanoscale semiconductor optical devices
Project: PhD

**Kompakte Fiberbaserede Ultrahurtige Pulskilder**
Greibe, T., PhD Student, Department of Photonics Engineering
Hvam, J. M., Main Supervisor
Birkedal, D., Supervisor
Yvind, K., Supervisor
Mark, J., Examiner
Hanberg, J., Examiner
Larsson, A. G., Examiner
Centerfinansieret
01/09/2001 → 01/03/2007
Award relations: Kompakte Fiberbaserede Ultrahurtige Pulskilder
Project: PhD

**Nano-structured filters**
Pu, M., PhD Student, Department of Photonics Engineering
Hvam, J. M., Main Supervisor
Ou, H., Supervisor
Yvind, K., Supervisor
Kristensen, A., Examiner
Borel, P. I., Examiner
Van Thourhout, D., Examiner
Programbevilling
01/09/2007 → 20/04/2011
Award relations: Nano-structured filters
Project: PhD

**Hybrid light emitting diode enhanced with emissive nanocrystals**
Kopylov, O., PhD Student, Department of Photonics Engineering
Optical Sampling Coherent communication receivers
Caballero Jambrina, A., PhD Student, Department of Photonics Engineering
tafur Monroy, I., Main Supervisor, Department of Photonics Engineering
Yvind, K., Supervisor, Department of Photonics Engineering
Zibar, D., Supervisor, Department of Photonics Engineering
Christensen, L. C., Examiner, Department of Informatics and Mathematical Modeling
Capmany, J., Examiner
Forskningsrådsfinansiering
01/10/2008 → 30/09/2011
Award relations: Optical Sampling Coherent communication receivers
Project: PhD

Surface acoustic modulation of planar photonic circuits
Barretto, E. C. S., PhD Student, Department of Photonics Engineering
Hvam, J. M., Main Supervisor
Poel, M. V. D., Supervisor
Yvind, K., Supervisor
Bruus, H., Examiner
Borel, P. I., Examiner
de Lima Jr., M. M., Examiner
Forskningsrådsfinansiering
01/09/2007 → 24/08/2011
Award relations: Surface acoustic modulation of planar photonic circuits
Project: PhD

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

Modelling of Ultrafast Semiconductor Components
Nielsen, J. A., PhD Student, Department of Photonics Engineering
Merk, J., Main Supervisor
Yvind, K., Supervisor
Hvam, J. M., Examiner
Lenstra, D., Examiner
Willatzen, M., Examiner
Forskningsrådsfinansiering
01/01/2003 → 29/10/2007
Award relations: Modelling of Ultrafast Semiconductor Components
Project: PhD
Optical switching in nanophotonic structures
Yu, Y., PhD Student, Department of Photonics Engineering
Mørk, J., Main Supervisor
Yvind, K., Supervisor
Morioka, T., Examiner
Krauss, T. F., Examiner
Manning, R. J., Examiner
Institut/centerfinansieret
01/09/2011 → 18/03/2015
Award relations: Optical switching in nanophotonic structures
Project: PhD

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

Processing and Characterization of Quantum dot Devices
Hansen, P. L., PhD Student, Department of Photonics Engineering
Mørk, J., Main Supervisor
Poel, M. V. D., Supervisor
Yvind, K., Supervisor
Hvam, J. M., Examiner
Eisenstein, G., Examiner
Marcinkevicius, S., Examiner
Forskningsrådsfinansiering
15/06/2006 → 26/05/2010
Award relations: Processing and Characterization of Quantum dot Devices
Project: PhD

Electrically pumped nanolaser for terabit communication
Lupi, A., PhD Student, Department of Photonics Engineering
Yvind, K., Main Supervisor
Chung, I., Supervisor
Oxenløwe, L. K., Examiner
Birkedal, D., Examiner
Roelkens, G., Examiner
Eksternt finansieret virksomhed
15/03/2012 → 17/02/2016
Award relations: Electrically pumped nanolaser for terabit communication
Project: PhD

Next generation optical metropolitan area networks
Tatarczak, A., PhD Student, Department of Photonics Engineering
Tafur Monroy, I., Main Supervisor
Jensen, J. B., Supervisor
Yvind, K., Examiner
Chaciński, M., Examiner
Kocot, C., Supervisor
Meissner, P., Examiner
Samfinansieret - Andet
15/12/2013 → 02/11/2016
Award relations: Next generation optical metropolitan area networks
Project: PhD
QUEENs: QUantum dot Energy level Engineering for laser applicatioNs on InP and Si platforms
This project is dedicated to the research of quantum dot (QD) epitaxial growth on both indium phosphide (InP) and silicon (Si) based platforms with the aim of creating superior gain material emitting in the 1.5-1.6 μm wavelength range. The majority of the proposed research is quite fundamental but will have noticeable impact to device applications for our everyday life in the near future. Diverse areas like telecommunication, optical coherence tomography including medical applications, sensing, computer and network clock-distribution, THz generation, and metrology can benefit from the materials investigated. The projected research covers two directions. The first is the development of QDs which possess desired electronic and optical properties in the InP based material system, i.e. tailoring the energy level structure and wave functions in the dots. Manipulating the shape, chemical composition and surroundings of the nanostructures is the key to achieving the set goals. In the frame of the project I will implement two different approaches to design and grow high optical quality arrays of QDs. Those approaches are self-assembled quantum dot growth and selective area growth using block copolymer lithography. The second direction of the research is the deployment of the highly efficient QD gain material to a silicon platform. The development of epitaxial growth technology of III-V materials on Si combines the benefits of high optical quality III-V QD gain material with low cost silicon photonics, which is a key platform to push towards increased integration, higher speed and lower energy consumption.

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External Project ID: VKR023442
**SiMOF: CMOS-Compatible Silicon-Based Micro-Ring Resonator for On-Chip Optical Frequency Comb Generation (SiMOF)**

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Peucheret, C., Project Participant

**Project ID:** 70705  
**External Project ID:** FTP 11-117031  
**01/01/2012 → 30/09/2015**  
**Project:** Research

**High-speed Laser with Ultralow Energy Consumption for Silicon Photonics**

This project aims to investigate and demonstrate a novel laser structure that appears as a very promising high-speed, ultralow-energy-consumption light source for silicon photonics. The laser structure differs from conventional designs in that the active material (III-V semiconductor) is incorporated into one of the mirrors, a so-called high-index-contrast grating mirror, which provides very strong field confinement within the grating. This allows ultra-small lasers with very efficient energy conversion of electrons to photons simultaneously with a high modulation bandwidth. At the same time, the laser can be integrated onto a silicon chip, allowing the realization of the long-time dream of integrating photonics and electronics on the same chip. In this integrated chip, one can exploit the properties of electrons for processing data and the properties of photons for transmitting data. This vision of silicon photonics is being actively pursued by companies like IBM and Intel, but the light source remains the critical component. Considerable interest shown by several companies reflects the potential of this innovative laser structure. The novel structure that we wish to investigate, however, has some fundamental challenges. Thus, a good understanding of the mode properties, the electrical transport and the thermal issues is needed. Also, the technology for integrating the active material (buried heterostructure) within the grating mirror needs to be developed. The project will thus rely on a close interaction between theory, design, fabrication and characterization. The knowledge gained in this project can form the background for research and development of a new class of ultra-small and highly-integrated photonic devices.

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**01/01/2012 → 31/12/2014**  
**Keywords:** Hybrid, Silicon photonics, optical interconnects, low energy consumption  
**Project:** Research

**NESTOR: Nano-engineered silicon for Terabit per second optical processing**

Silicium er det nærmest forekommende materiale i jordens skorpe efter oxygen, og besidder så gode halvlederegenskaber, at det er blevet til grundstenen i moderne elektronik. Men silicium er nu også begyndt at blive populært i fotonik kredse, idet silicium har vist sig også at besidde nogle godt skjulte, men meget eftertragtede optiske egenskaber, som kan bruges til at kontrollere lys med. På DTU, Institut for Fotonik, har man nu opdaget at ren silicium ikke alene kan kontrollere lys, men kan gøre det på en så kort tidsskala at det muliggør optisk signalbehandling af terabit per sekund optiske data signaler. Denne effekt opnåes når man kombinerer nanoteknologi med silicium bølgelederfabrikation. DTU Fotonik har verdens førende laboratorium indenfor højhastighed optisk kommunikation, og med opdagelsen af terabit potentialet i silicium åbnes der nu for hiltid uanede muligheder indenfor dette forskningsfelt. Med ren silicium kan man nu komme i gang med at skabe den meget omtalte optiske chip med terabit per sekund kapacitet. Kickstartet af denne banebrydende opdagelse, vil dette projekt fokusere på at opbygge en dybere forståelse af fænomenet for at udnytte dette til at optimere silicium bølgelederne således at der kan designes et helt chip sæt der kan udføre flere forskellige komplicerede optiske funktionaliteter ved terabit/s data hastigheder.

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Galili, M., Project Participant  
Yvind, K., Project Participant  
Dalgaard, K., Project Participant

**Project ID:** 70695  
**Forskningsrådene - Andre:** DKK5,758,373.00  
**01/12/2011 → 31/12/2014**  
**Collaborators:** Technical University of Denmark  
**Award relations:** Nano-engineered silicon for Terabit per second optical processing  
**Project:** Research
NATEC: Nanophotonics for terabit communications: VKR Centre of Excellence - NATEC

We propose to establish a Willum Kann Rasmussen Centre of Excellence that explores the fundamental physics and technology of nanophotonic materials and devices in order to reach data rates in the terabit per second regime. Following a brief introduction, the goals of the Centre, its organization, the main research activities, research plans and proposed budget are described.

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01/09/2008 → 31/08/2014
Award relations: Nanophotonics for terabit communications: VKR Centre of Excellence - NATEC
Project: Research

GOSPEL: Governing the speed of light

The GOSPEL project aims at developing new, highly effective technologies for enabling slow and fast light propagation as a tunable feature in photonic devices. In fact, controlling the speed of light offers a solution to a necessary, and often missing, functionality in broadband ICT systems: a time-delay/phase-shift line. The proposed research will address three slow and fast light device platforms: linear and nonlinear semiconductor photonic crystal waveguides with position controlled embedded quantum dots, active semiconductor waveguides based on quantum dots and advanced, specifically engineered optical fibers. These technologies will be harnessed in microwave and millimeter wave applications, such as: true time delay antenna feed systems for radars and ultra wide band wireless communication; complex microwave filters; high spectral purity opto-electronic oscillators and electro optical sampling systems. This project gathers world leading experts in microwave photonics and semiconductor and fiber technologies, under a unified vision of the role that slow and fast light can play in advanced microwave applications. The project tackles several key challenges of the 7th Framework Work programme in the ICT domain and represents a significant step towards the removal of a major roadblock, i.e. the lack of practical, tunable, broadband, low distortion time-delay/phase-shift lines for microwave signals. This elemental component, besides enabling several applications, can ease the convergence of photonics and electronics and can attribute new functions to photonic devices. The proposed fundamental research will produce new results in multidisciplinary topics like semiconductor physics, quantum dots, photonic crystal design and fiber technology and it will also represent a significant advancement across many sectors of ICT.

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Project ID: 70445
External Project ID: info:eu-repo/grantAgreement/EC/FP7/219299
Forsk. EU - Rammeprogram: DKK2,380,000.00
01/09/2008 → 31/12/2011
Award relations: Governing the speed of light
Project: Research

QUEST: Quantum dot structures enabling light slow-down and amplification

QUEST is a research project exploring the use of semiconductor quantum dot technology for realizing practical slow-light devices and integrated optical amplifiers. Such devices find important applications within information, communication and sensor technology and the project targets practical demonstrations within these areas, leading to possibilities of commercial exploitation. From a wider perspective, the proposed project contributes to the ongoing evolution of the information society. The project brings together three groups from the Technical University of Denmark (DTU) and The University of Southern Denmark (SDU) with strong and complementary research experience.

Mørk, J., Project Manager, Department of Photonics Engineering, Nanophotonic Devices
Hvam, J. M., Project Participant, Department of Photonics Engineering, Nanophotonic Devices
Separation of Macromolecules by Photonic Crystal Defect Chromatography
This project introduces a new and revolutionary way to separate macromolecules. The principle is to use light to selectively retain some molecules over others depending on their differential interaction with optical fields. We call the method Photonic Crystal Defects Chromatography (PCDC), as it combines photonic crystals with artificial defects and a flow channel that constitutes a “column” of conventional liquid chromatography. The method will be useful both for biopolymers (like DNA and proteins) and synthetic polymers. It could potentially have profound implications for several biological and biomedical applications such as proteomics and cancer diagnostics, in which fast and high resolution separation of nucleic acids and proteins from a complex biological fluid is a key aspect.

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Forskningsrådene - STVF: DKK12,269,000.00
Project ID: 70319
Collaborators: University of Southern Denmark
Award relations: Separation of Macromolecules by Photonic Crystal Defect Chromatography
Project: Research

Coherent encoding of THz signals onto optical signals by THz electro-absorption effect in quantum dots, enabling Tbit/s data rates in Radio-over-Fiber systems
Direct and polarization-independent modulation of electro-absorption in quantum dots (QDs) resonant with the optical carrier, by an incident stream of THz pulses. QD is a smallest possible semiconductor element, consisting of only a few thousands of atoms. The RC-constant of a QD is negligible, thus providing for virtually unlimited switching speeds, if the QD is addressed directly by high-frequency modulation signal.

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Forsk. Andre statslige danske i øvrigt: DKK750,000.00
Project ID: 70575
Collaborators: Innolume GmbH, Delft University of Technology, University of Hamburg
Award relations: Coherent encoding of THz signals onto optical signals by THz electro-absorption effect in quantum dots, enabling Tbit/s data rates in Radio-over-Fiber systems
Project: Research

GigaWaM: Giga Bit Access Passive Optical Network Using Wavelength Division Multiplexing
The need for speed is a never ceasing requirement for broadband access. Fibre-to-the-home (FTTH) is the fastest alternative. Driven by new demands the total number of homes with FTTH is forecasted to grow to 86 million or 5% of the households worldwide by 2012. Wavelength Division Multiplexing Passive Optical Network (WDM-PON) is widely seen as the ultimate solution for the future FTTH. Korea is the first country to deploy WDM-PON and in Japan and the US important players have revealed plans to follow. The GigaWaM project will develop a complete fibre optical subsystem for WDM-PON providing 1Gbps per user. In the past data rates doubled every 12 months and 1 Gbit/s is expected around 2016. Convergence of telephony, TV and internet into so-called triple-play service and new applications such as High Definition TeleVision (HDTV) are the latest drivers. Networks based on copper cable may reach 10 Mbps while the capacity required just for one channel of HDTV is 20 Mbps. Thus copper cables are to be replaced by optical fibres soon, for which GigaWaM is perfectly timed to offer all the needed optical components (for home, supplier’s site and the multiplexer in between) providing 64 Gbps per fibre or 6 times higher capacity than currently offered optical systems at a
60% lower cost. This cost reduction will be achieved by a 100 times higher level of integration of optical components, for which the level of integration today is comparable to the 1970’s level for electronic components. The market for optical components for FTTH will be Euro 1.3 billion in 2015. Europe lags behind in fibre deployment, which will be accelerated by the availability of the low cost optical components developed in the project. The consortium (5 SME’s 2 research institutions and Ericsson) represents a complete European food chain from technology providers to the system vendor by strengthening the competitiveness of Europe on the market for optical network components and creating new high-end jobs.

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Project ID: 70432
Forskningsrådene - STVF: DKK266,144.00
01/03/2008 → 31/03/2011
Award relations: Giga Bit Access Passive Optical Network Using Wavelength Division Multiplexing
Project: Research

**Photonic devices for multi-wavelength amplification and regeneration (M-WARE)**

In an optical communication system information is sent using light signals that travel through a glass fiber. The signals experience difference forms of degradation which decrease signal quality and therefore have to be compensated for by signal regeneration. In order to increase the capability of communication systems several wavelength channels are sent through the same fiber, using a technique called wavelength division multiplexing (WDM). When regenerating a WDM signal the wavelengths have to be separated and regenerated in parallel, which makes the process complex and difficult. The aim of the proposed project is to develop a 2R-regenerator (re-amplification and re-shaping) capable of regenerating several wavelength channel simultaneously in a single device. The means of reaching this goal will be devices using saturable gain and absorption in quantum dot and quantum well semiconductor materials. Quantum dots of different sizes interact with light of different wavelengths and make it possible to regenerate them independently from each other. The project will focus on designing materials and devices for optimising this effect. A fast limiting amplifier is one part of the envisioned 2R device with important applications of its own. A QD limiting amplifier will therefore be a first important milestone. Device processing will be made at the new processing facilities at DANCHIP, DTU and the material growth will be made together with partners in the European network of excellence ePIXnet. The project is based on experience from two Ph.D. projects which have demonstrated and investigated single wavelength regeneration in similar devices.

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Project ID: 70318
Forskningsrådene - STVF: DKK2,122,800.00
Hvam, J. M., Project Manager, Department of Photonics Engineering, Nanophotonic Devices

Coating can be deposited on the facet around the stripe. After defining the electrical contacts, the wafer is cleaved into single devices and an anti-reflection coating is grown around the active region. The slab is created by masking 2-3 mm wide stripes and dry etch ~2 mm of the material away where a slab of semiconductor (high index) material on top of the active region will increase the effective refractive index.

Phosphide based wafers with operating wavelengths of about 1.5 mm. The waveguides are ridge waveguide structures and consist of short optical pulses. All the devices are being processed using in the facilities of GIGA. The material is Indium Phosphide based and the waveguides are ridge waveguide structures where a slab of semiconductor (high index) material on top of the active region will increase the effective refractive index.

The slab is created by masking 2-3 mm wide stripes and dry etching ~2 mm of the material away, where a slab of semiconductor (high index) material on top of the active region will increase the effective refractive index. This can be exploited to use the EAs as all-optical gates, enabling a dramatic reduction in size and switching energy. Their switching energy*delay product is two orders of magnitude smaller than that of competing technologies. Modelling will consider carrier plasma (spectral and spatial) contributions to the nonlinear optical response and develop a robust optical, thermal and electronic design tool for photonic crystal devices. New levels of photonic crystal integration will be pursued to combine these devices and achieve complex all-optical functions attractive to both medium- and long-term markets.

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Project ID: 70629
Forsk. EU - Andre EU-midler: DKK3,654,000.00
01/07/2012 → 01/07/2015
Collaborators: University of Nottingham, Centre National de la Recherche Scientifique, MergeOptics GmbH, Università degli studi di Ferrara, Thales

COPERNICUS: Compact Otdm/wdm oPtical rEceiveRs based on photoNic crystal Integrated
COPERNICUS aims to develop compact demultiplexing receivers for 100 Gb/s optical time division multiplexed (OTDM) and wavelength division multiplexed (WDM) signals, based on photonic crystal technology. There is a pressing need for these devices for ultra-high bandwidth data links in server farms, optical storage networks and on-board internet/entertainment systems, where demand is driving the data bandwidth and technology integration level rapidly upwards. Next generation telecom systems will also benefit from these devices for OTDM and optical packet switching. Their high-speed and bandwidth, together with their ultra-low power consumption and extreme compactness, also make them a very promising technology for seamless cross-chip and off-chip data links for CMOS electronics. This approach has all the hallmarks of a highly disruptive technology with the potential to place Europe at the forefront of photonics. COPERNICUS targets advances in the physics, technology, modelling, and integration of photonic crystal devices. Key devices include high-speed all-optical gates, low-crosstalk wavelength drop filters, and high-speed integrated photodetectors. These devices rely on very strong light-matter interactions arising from the large, ultrafast nonlinear optical response of III-V semiconductors and the strong resonant field enhancement in photonic crystals. This is ideal for filters and all optical gates, enabling a dramatic reduction in size and switching energy. Their switching energy*delay product is two orders of magnitude smaller than that of competing technologies. Modelling will consider carrier plasma (spectral and spatial) contributions to the nonlinear optical response and develop a robust optical, thermal and electronic design tool for photonic crystal devices. New levels of photonic crystal integration will be pursued to combine these devices and achieve complex all-optical functions attractive to both medium- and long-term markets.

Component production and characterization/SCOOP (Semiconductor COmponents for Optical signal Processing)
Within the SCOOP project, a number of different optoelectronic devices will be designed, processed and experimentally evaluated. These devices can be divided into 3 groups: Electroabsorbers (EAs): Modulation of the reverse bias of the active region in a semiconductor waveguide will modulate the optical absorption. This can be exploited to use the EAs as de-multiplexers where a high bit-rate signal can be reduced to a lower frequency signal that can be easily detected by electronics. Interferometric devices: In a non-linear media like semiconductors, the refractive index depends on the carrier density. This can be utilised to change the phase in one optical arm in an interferometer to alter between constructive and destructive interference. By using a low frequency optical pulse to create the phase change these devices can be used as de-multiplexers. The first generation devices will consist of interferometric structures of Michelson or Mach-Zender type. Lasers: A range of lasers for mode-locked operation are being processed. The devices comprise of a ~350 mm long gain section and a shorter (~30 mm) absorber section. By inserting the laser into an external cavity and modulating the driving current for either the gain or the absorption regions, the mode-locked regime can be reached where the laser output consists of short optical pulses. All the devices are being processed using in the facilities of GIGA. The material is Indium Phosphide based wafers with operating wavelengths of about 1.5 mm. The waveguides are ridge waveguide structures where a slab of semiconductor (high index) material on top of the active region will increase the effective refractive index around the active region. The slab is created by masking 2-3 mm wide stripes and dry etch ~2 mm of the material away around the stripe. After defining the electrical contacts, the wafer is cleaved into single devices and an anti-reflection coating can be deposited on the facet.

Hvam, J. M., Project Manager, Department of Photonics Engineering, Nanophotonic Devices
HALVEDLERLASERE ER SMÅ, BILLIGE OG ENERGIEFFEKTE LASERE, DER ANVENDES MANGE STEDER I VORES DAGLIGDAG. I NOGLE SPECIALISERETE ANVENDELSER BRUGES I DAG OFTEN ANDRE TYPER AF LASERE, F. EKS. DIODEPUMPEDE FASTSTOFLASERE, FORDI DE KAN LEVERE EN BEDRE YDELSE PÅ ET FLERE OMRÅDER. ET EKSEMPEL ER KORT-PULS LASERE, HØV MAN I SPEZIELLE LASERSYSTEMER KAN GENERERE PULSER, DER ER FÅ FEMTOSEKUNDER LANGE (OG VIA EFTERFØLGENDE IKKE-LINÆRE PROCESSER KAN DE BRinges NED I ATTOSEKUNDER OMRADET). SÅDANNE LASERE HAR TILIND NUM RÆTEN PÆNEN PÅ CA. 1 PIKOSUNDKES FOR HVOR KORTE PULSER MAN KAN GENERERE, OG LASERNE HAR TYPISK EN REPETITIONS RATE HØJERE END 10GHZ, HVLJKET MINDSKER MÅKSIMAL-EFFEKTERERINGEN I PULSERNE I FORHOLD TIL LAVERE REPETITIONS RATERE. BEGRÆNSNINGEN SKYLDES DEN KOMPILERETE LADNINGSBÆREREDEYDING I HALVEDLERMATERIELERNE, DER RESULTERER I USTABILE PULSTOG OG ØNSKETE OPSPILNING AF PULSERNE. Dette ER FORÅRSAGET AF EN UHENSIGTSMÆSSEGLUG RUMTIG, TIDSIG OG ENERGETISK FORDELING AF LADNINGSBÆRERNE I MATERIALET. VED BRUG AF AVANCERETE NANOETNOLOGI VIIL PROJEKTET DEMONSTRERE, AT DET ER MULIGT TÆNDERE DYNAMIKKEN I LASERMEDLET OPTISK FORSTÆRKER OG MÆTBAR ABSORBER, SÅ DET KOMBINERETE RESPONS GIVER ULTRAKORTE PULSER. I PROJEKTET VIL VI BENYTE VORES Erfarings INDEN FOR ULTRAHURTIG DYNAMIK I HALVEDLER, NANOFABRIKATION OG AVANCERETE MÅLINGER PÅ KORT-PULS LASERE TIL AT FLYTTE GRÆNSEN FOR YDELSEN AF KOMPAKTE HALVEDLERBASEREDERE KORT-PULS LASERE, OG DERMED OGSÅ ÆVIDE PALETTEN AF ANVENDELSESÆGREDIGHEDER FOR KORT-PULS LASERE GENERELT.

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Project: Research
Project ID: 70488
Forskningsrådene - Andre: DKK5,291,888.00
01/09/2009 → 31/10/2012
Keywords: Mode-locked lasers, Semiconductor optoelectronics, Ultrafast dynamics, Nanotechnology
Collaborators: University of Cambridge
Award relations: Femtosecond semiconductor LASers Harnessed

Optical coherent control in photonic nanostructures

In the project, photonic nanostructures will be employed for controlling emission of light from semiconductor quantum dots. We propose fabricating ultra compact and high quality optical cavities in photonic crystals. Such nano-cavities will provide a new technology for effective low-threshold lasers and single-photon sources. Furthermore, the project will contribute to fundamental understanding of quantum optical properties of solid-state nanostructures, and their potential for scalable quantum logic.

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Project: Research
Project ID: 70299
Forskningsrådene - STVF: DKK2,220,000.00
01/09/2005 → 31/08/2008
Award relations: Optical coherent control in photonic nanostructures

Optoelectronic integration technologies

The project falls in two stages. First a reliable process has to be set up using the new compound semiconductor processing equipment, such that isolated ”standard components” can be fabricated. This will also include testing fabrication using a newly installed e-beam writer. The focus will be components for high-speed optical communication systems in the 1.55mm wavelength range thus employing InGaAsP on InP. Next, when the growth apparatus (Emcore D125) has been installed, integration of mode-locked lasers with signal processing devices will be performed.
Yvind, K., Project Manager, Department of Photonics Engineering, Nanophotonic Devices
Larsson, D., Project Participant, Department of Photonics Engineering, Nanophotonic Devices
Mørk, J., Project Participant, Department of Photonics Engineering, Nanophotonic Devices
Hvam, J. M., Project Participant, Department of Photonics Engineering, Nanophotonic Devices
Greibe, T., Project Participant, Department of Photonics Engineering, Nanophotonic Devices

Project ID: 70267
Forskningsrådene - STVF: DKK1,500,000.00
01/08/2004 → 31/07/2006
Award relations: Optoelectronic integration technologies
Project: Research

Activities:

Monolithic integration of immersed InP on Si
Period: 3 Jun 2018 → 8 Jun 2018
Dmitrii Viazmitinov (Speaker)
Lars Hagedorn Frandsen (Other)
Kresten Yvind (Other)
Elizaveta Semenova (Other)
Department of Photonics Engineering
Degree of recognition: International
Links:
http://www.icmovpe.jp/program/ICMOVPE-XIX-Final_Program.pdf (conference program)

Related event
19th International Conference on Metalorganic Vapor Phase Epitaxy (ICMOVPE-XIX)
03/06/2018 → 08/06/2018
Nara, Japan
Activity: Talks and presentations › Conference presentations

Tunable MEMS VCSEL on silicon substrate
Period: 12 Apr 2018 → 13 Apr 2018
Hitesh Kumar Sahoo (Speaker)
Thor Ansbæk (Speaker)
Luisa Ottaviano (Speaker)
Elizaveta Semenova (Speaker)
Fedor I. Zubov (Guest lecturer)
Ole Hansen (Speaker)
Kresten Yvind (Speaker)
Centre of Excellence for Silicon Photonics for Optical Communications
Quantum and Laser Photonics
High-Speed Optical Communication
Nanophotonic Devices
Department of Photonics Engineering
Degree of recognition: International

Related event
11th European VCSEL Day 2018
12/04/2018 → 13/04/2018
Ulm, Germany
Activity: Talks and presentations › Conference presentations

Annual Conference on Commercialization of Micro and Nano Systems
Period: 30 Aug 2009 → 4 Sep 2009
Kresten Yvind (Participant)
Department of Photonics Engineering
Nanophotonic Devices

**Description**
Annual Conference on Commercialization of Micro and Nano Systems (COMS); 14: Acetone vapor sensing using a vertical cavity surface emitting laser diode coated with polystyrene

We report theoretical and experimental on a new vapor sensor, using a single-mode vertical-cavity surface-emitting laser (VCSEL) coated with a polymer sensor coating, which can detect acetone vapor at a volume fraction of 2.5%. The sensor provides the advantage of standard packaging, small form-factor, mechanical stability and low cost when combined with a monolithically integrated photodiode detector.

Place: Copenhagen, Denmark
Degree of recognition: International

**Related event**

Annual Conference on Commercialization of Micro and Nano Systems
30/08/2009 → 04/09/2009
Copenhagen, Denmark
Activity: Attending an event › Participating in or organising a conference

**Talk about "Fabrication of Cantilevers by Nanoimprint Lithography" Presented at "International Workshop on Cantilever sensors"**
Period: 19 May 2008 → 21 May 2008
Kresten Yvind (Speaker)
Department of Photonics Engineering
Nanophotonic Devices

**Description**
Place: Mainz, Germany

**Related external organisation**

Unknown external organisation
Activity: Talks and presentations › Conference presentations

**Talk about "laser self-mixing interferometry in VCSELs - an ultra-compact and massproceable deflection detection system for Nanomechanical Polymer cantilever sensors" Presented at "International workshop on cantilever Sensors"**
Period: 19 May 2008 → 21 May 2008
Kresten Yvind (Speaker)
Department of Photonics Engineering
Nanophotonic Devices

**Description**
Place: Mainz, Germany

**Related external organisation**

Unknown external organisation
Activity: Talks and presentations › Conference presentations