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 facet, total internal reflection from a periodic stack of layers, Bragg reflection from a high contrast grating or random scattering in a disordered medium. 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 has recently been explored in a number of different photonic and plasmonic systems. 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. Such a source is of interest for a number of applications within integrated photonics.
Optical Time Domain Demultiplexing using Fano Resonance in InP Photonic Crystals

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonics Theory and Signal Processing, High-Speed Optical Communication, Centre of Excellence for Silicon Photonics for Optical Communications, Nanophotonic Devices
Authors: Bekele, D. A. (Intern), Yu, Y. (Intern), Bony, P. (Intern), Ottaviano, L. (Intern), Oxenløwe, L. K. (Intern), Yvind, K. (Intern), Mørk, J. (Intern)
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Source-ID: 134869139
Publication: Research - peer-review › Conference abstract for conference – 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 crystal platform is discussed.

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonics Theory and Signal Processing, High-Speed Optical Communication, Centre of Excellence for Silicon Photonics for Optical Communications, Nanophotonic Devices
Number of pages: 7
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Host publication information
Theory and simulations of self-pulsing in photonic crystal Fano lasers

A detailed theoretical and numerical investigation of the dynamics of photonic crystal Fano lasers is presented. It is shown how the dynamical model supports self-pulsing, as was recently observed experimentally, and an in-depth analysis of the physics of the self-pulsing mechanism is given. Furthermore, it is demonstrated how different dynamical regimes exist, and these are mapped out numerically, showing how self-pulsing or continuous-wave output may be controlled through the strength of the pump and the detuning of the nanocavity. Finally, laser phase transitions through dynamical perturbations are demonstrated.

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonics Theory and Signal Processing
Authors: Rasmussen, T. S. (Intern), Yu, Y. (Intern), Mørk, J. (Intern)
Pages: 83-84
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Publisher: IEEE
ISBN (Print): 978-1-5090-5323-0/
Main Research Area: Technical/natural sciences
Conference: 17th International Conference on Numerical Simulation of Optoelectronic Devices, Lyngby, Denmark, 24/07/2017 - 24/07/2017
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Theory of Self-pulsing in Photonic Crystal Fano Lasers

Laser self-pulsing was a phenomenon exclusive to macroscopic lasers until recently, where self-starting laser pulsation in a microscopic photonic crystal Fano laser was reported. In this paper a theoretical model is developed to describe the Fano laser, including descriptions of the highly-dispersive Fano mirror, the laser frequency and the threshold gain. The model is based upon a combination of conventional laser rate equations and coupled-mode theory. The dynamical model is used to demonstrate how the laser has two regimes of operation, continuous-wave output and self-pulsing, and these regimes are characterised using phase diagrams, establishing the regime of self-pulsing numerically. Furthermore, the physics behind the self-pulsing mechanism are explained in detail and it is demonstrated how cavity absorption makes the Fano mirror function as a saturable absorber, leading to Q-switched pulse generation. A stability analysis is used to demonstrate how the dominant mechanism of instability is relaxation oscillations becoming un-damped. Finally the effect of varying key self-pulsing parameters is investigated by characterisation of the change in self-pulsing regions.

General information
State: E-pub ahead of print
Organisations: Department of Photonics Engineering, Nanophotonics Theory and Signal Processing
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.

General information
State: Published
Spectrally and temporally resolved resonance shifts of a photonic crystal cavity switch

We present experimental results of temporally and spectrally resolved transmission measurements of a photonic crystal cavity using two-color pump-probe technique. With a gated spectral measurement, we measure the resonance shift's dependence on pump power.

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonics Theory and Signal Processing, Department of Micro- and Nanotechnology
Authors: Hansen, P. L. (Intern), Yu, Y. (Intern), Mørk, J. (Intern)
Number of pages: 2
Publication date: 2016
Spectral symmetry of Fano resonances in a waveguide coupled to a microcavity

We investigate the symmetry of transmission spectra in a photonic crystal (PhC) waveguide with a side-coupled cavity and a partially transmitting element (PTE). We demonstrate, through numerical calculations, that by varying the cavity-PTE distance the spectra vary from being asymmetric with the minimum blueshifted relative to the maximum, to being symmetric (Lorentzian), to being asymmetric with the minimum redshifted relative to the maximum. For cavity-PTE distances larger than five PhC lattice constants, we show that the transmission spectrum is accurately described as the transmission spectrum of a Fabry–Perot etalon with a single propagating Bloch mode and that the symmetry of the transmission spectrum correlates with the Fabry–Perot round-trip phase.
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.

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonics Theory and Signal Processing, High-Speed Optical Communication, Risø National Laboratory for Sustainable Energy, Department of Micro- and Nanotechnology, Centre of Excellence for Silicon Photonics for Optical Communications, Nanophotonic Devices
Authors: Yu, Y. (Intern), Palushani, E. (Intern), Heuck, M. (Intern), Oxenløwe, L. K. (Intern), Yvind, K. (Intern), Mørk, J. (Intern)
Pages: 395-398
Publication date: 2016
Main Research Area: Technical/natural sciences

Publication information
Journal: Frontiers of Optoelectronics
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
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Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.33 SJR 3.56 SNIP 2.133
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 3.823 SNIP 2.205 CiteScore 5.76
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 5.027 SNIP 2.646 CiteScore 6.62
Ultrafast coherent dynamics of a photonic crystal all-optical switch

We present pump-probe measurements of an all-optical photonic crystal switch based on a nanocavity, resolving fast coherent temporal dynamics. The measurements demonstrate the importance of coherent effects typically neglected when considering nanocavity dynamics. In particular, we report the observation of an idler pulse. The measurements are in good agreement with a theoretical model that allows us to ascribe the observation to oscillations of the free carrier population in the nanocavity. The effect opens perspectives for the realization of new all-optical photonic crystal switches with unprecedented switching contrast.
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 5.441 SNIP 3.089
Web of Science (2002): Indexed yes
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 5.92 SNIP 3.111
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Electronic versions:
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Source: FindIt
Source-ID: 2319756494
Publication: Research - peer-review › Journal article – Annual report year: 2016

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.

General information
State: Published
Organisations: Department of Photonics Engineering, Nanophotonics Theory and Signal Processing, High-Speed Optical Communication, Nanophotonic Devices, Department of Micro- and Nanotechnology
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Main Research Area: Technical/natural sciences
Conference: 2015 Conference on Lasers and Electro-Optics 2015 (CLEO), San Jose, CA, United States, 10/05/2015 - 10/05/2015
high-speed optical techniques, nanophotonics, nonlinear optics, photoemission, photonic crystals, General Topics for Engineers, Photonics and Electrooptics, backward transmission levels, Cavity resonators, Couplings, forward transmission levels, Nonlinear optics, nonlinear photonic-crystal Fano structure, nonreciprocal transmission, Optical bistability, Optical waveguides, Photonics, single nanocavity, spatial symmetry breaking, ultrafast carrier nonlinearities, Ultrafast optics
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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.

General information
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Organisations: Department of Photonics Engineering, High-Speed Optical Communication, Nanophotonics Theory and Signal Processing, Nanophotonic Devices, Metro-Access and Short Range Systems
Investigations on the parity of Fano resonances in photonic crystals
We investigate the relation between the parity of Fano resonances and field distribution in a photonic crystal structure using Fourier modal method, establishing a correlation between Fano parity and field profile.

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.
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.

**General information**

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Organisations: Department of Photonics Engineering, Nanophotonics Theory and Signal Processing, Nanophotonic Devices, Department of Micro- and Nanotechnology
Authors: Xue, W. (Intern), Yu, Y. (Intern), Ottaviano, L. (Intern), Semenova, E. (Intern), Yvind, K. (Intern), Mørk, J. (Intern)
Number of pages: 3
Pages: 1-3
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ISBN (Print): 9781467379441
Main Research Area: Technical/natural sciences
Conference: Opto Electronics and Communications Conference 2015, Shanghai, China, 28/06/2015 - 28/06/2015
Communication, Networking and Broadcast Technologies, Fields, Waves and Electromagnetics, Photonics and Electrooptics, Cavity resonators, Epitaxial growth, Integrated optics, Optical losses, Optical pumping, Photonics, Solids
DOIs: 10.1109/OECC.2015.7340132
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.

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

General information

State: Published
Organisations: Department of Photonics Engineering, Nanophotonics Theory and Signal Processing, High-Speed Optical Communication, Nanophotonic Devices
Authors: Yu, Y. (Intern), Hu, H. (Intern), Oxenløwe, L. K. (Intern), Yvind, K. (Intern), Mørk, J. (Intern)
Pages: 2357-2360
Publication date: 2015
Main Research Area: Technical/natural sciences

Publication information

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BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.54 SJR 1.864 SNIP 1.658
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
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.
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.

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. 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**

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Scopus rating (2016): CiteScore 2.67 SJR 1.132 SNIP 0.996
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.085 SNIP 0.983 CiteScore 2.47
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.799 SNIP 1.462 CiteScore 3.25
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.149 SNIP 1.652 CiteScore 3.77
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.554 SNIP 1.754 CiteScore 3.76
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 2.805 SNIP 1.94 CiteScore 4.04
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.926 SNIP 1.789
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 2.857 SNIP 1.848
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 2.934 SNIP 1.83
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 3.039 SNIP 1.913
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 3.457 SNIP 2.288
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.

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.
Photonic Crystal Nanocavity Devices for Nonlinear Signal Processing

This thesis deals with the investigation of InP material based photonic crystal cavity membrane structures, both experimentally and theoretically. The work emphasizes on the understanding of the physics underlying the structures’ nonlinear properties and their applications for all-optical signal processing.

Based on the previous fabrication recipe developed in our III-V platform, several processing techniques are developed and optimized for the fabrication of InP photonic crystal membrane structures. Several key issues are identified to ensure a good device quality such as air hole size control, membranization of InP/InGaAs structure and wet etching.

Experimental investigation of the switching dynamics of InP photonic crystal nanocavity structures are carried out using short-pulse homodyne pump-probe techniques, both in the linear and nonlinear region where the cavity is perturbed by a relatively small and large pump power. The experimental results are compared with coupled mode equations developed based on the first order perturbation theory, and carrier rate equations we established for the dynamics of the carrier density governing the cavity properties. The experimental observations show a good consistency with the numerical simulations. The results provide insight into the nonlinear optical processes that govern the dynamics of nanocavities and are important for applications in optical signal processing. As a step forward, the components are further applied for system characterizations, demonstrating their ability for fast all-optical modulation with low energy consumption.

Another effort of this thesis is the theoretical design of the photonic crystal structures, such as mode adaptors for efficient in/out coupling, a four-port photonic crystal structure which allows two signals to excite different, yet spatially overlapping, resonances and are spatially separated at the output. This structure reduces the complexity of the system that usually includes band pass filters in order to distinguish the signals at the output. Finally, we may need to mention an important design: a simple and ultracompact photonic crystal structure consisting of a single cavity coupled with a waveguide, which allows very robust control of the transmission line shape. Lorentzian and Fano line shapes can be realized by varying the size of a single air-hole. Additional control of the parity of the Fano shape can be obtained by breaking the mirror symmetry of the structure. The turningpoint characteristic of Fano structures is experimentally demonstrated to allow the suppression of slow transmission dynamics, enabling us to achieve fast (20 Gbit/s) all-optical modulation with low energy consumption. Relying on spatial symmetry breaking and carrier nonlinearity, the Fano structure allows the demonstration of an enhanced nonreciprocal transmission with ultra-low power consumption and good wavelength tunability.
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.

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
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Organisations: Department of Photonics Engineering, Nanophotonics Theory and Signal Processing, High-Speed Optical Communication, Nanophotonic Devices
Authors: Colman, P. (Intern), Heuck, M. (Intern), Yu, Y. (Intern), Yvind, K. (Intern), Hansen, P. L. (Intern), Mørk, J. (Intern)
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ISBN (Print): 9781557529992
Series: Optics Infobase Conference Papers
ISSN: 2162-2701
Main Research Area: Technical/natural sciences
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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: 96698224
Publication: Research - peer-review › Article in proceedings – Annual report year: 2014

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.

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
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Publication date: 2014
Main Research Area: Technical/natural sciences
Active Photonic Crystal Switches: Modeling, Design and Experimental Characterization

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.

General information
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Organisations: Department of Photonics Engineering, Nanophotonics Theory and Signal Processing, Nanophotonic Devices
Authors: Heuck, M. (Intern), Yu, Y. (Intern), Kristensen, P. T. (Intern), Kuznetsova, N. (Intern), Yvind, K. (Intern), Mørk, J. (Intern)
Number of pages: 4
Pages: We.A6.3
Publication date: 2013

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Publisher: IEEE
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Main Research Area: Technical/natural sciences
Conference: 15th International Conference on Transparent Optical Networks (ICTON), Cartagena, Spain, 23/06/2013 - 23/06/2013
DOI: 10.1109/ICTON.2013.6602937
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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.

General information
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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.

General information
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BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.48 SJR 1.487 SNIP 1.589
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.976 SNIP 1.755 CiteScore 3.78
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.349 SNIP 2.166 CiteScore 4.18
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.358 SNIP 2.226 CiteScore 4.38
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.587 SNIP 2.145 CiteScore 3.85
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 2.579 SNIP 2.606 CiteScore 4.04
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.943 SNIP 2.466
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
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.

General information
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Organisations: Department of Photonics Engineering, Nanophotonics Theory and Signal Processing, Nanophotonic Devices, High-Speed Optical Communication
Number of pages: 2
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Publisher: IEEE
ISBN (Print): 978-1-4673-6476-8
Main Research Area: Technical/natural sciences
Conference: 2013 Conference on Lasers and Electro-Optics Pacific Rim, Kyoto, Japan, 30/06/2013 - 30/06/2013
DOI: 10.1109/CLEOPR.2013.6599952
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.

General information
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Organisations: Department of Photonics Engineering, Nanophotonics Theory and Signal Processing, Nanophotonic Devices
Authors: Yu, Y. (Intern), Heuck, M. (Intern), Ek, S. (Intern), Kuznetsova, N. (Intern), Yvind, K. (Intern), Mørk, J. (Intern)
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BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.67 SJR 1.132 SNIP 0.996
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.085 SNIP 0.983 CiteScore 2.47
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.799 SNIP 1.462 CiteScore 3.25
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.149 SNIP 1.652 CiteScore 3.77
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.554 SNIP 1.754 CiteScore 3.76
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 2.805 SNIP 1.94 CiteScore 4.04
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.926 SNIP 1.789
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 2.857 SNIP 1.848
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 2.934 SNIP 1.83
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.
Projects:

**Light-matter interaction and laser dynamics in nanophotonic structures**
Department of Photonics Engineering  
Period: 15/08/2017 → 14/08/2020  
Number of participants: 4  
Phd Student:  
Rasmussen, Thorsten Svend (Intern)  
Supervisor:  
Gregersen, Niels (Intern)  
Yu, Yi (Intern)  
Main Supervisor:  
Mørk, Jesper (Intern)  

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

**Optical switching in nanophotonic structures**
Department of Photonics Engineering  
Period: 01/09/2011 → 18/03/2015  
Number of participants: 6  
Phd Student:  
Yu, Yi (Intern)  
Supervisor:  
Yvind, Kresten (Intern)  
Main Supervisor:  
Mørk, Jesper (Intern)  
Examiner:  
Morioka, Toshio (Intern)  
Krauss, Thomas F. (Ekstern)  
Manning, Robert John (Ekstern)  

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