[1]Reza Salem, M A Foster ....All-optical regeneration on a Silicon chip, Optics Express Vol 15, 7802

[2]Fengnian Xia, M brooks...........Ultra-compact high order ring resonator flters using submicron silicon photonic wires for on-chip optical interconnects, Optics Express, Vol 15, 11934

Organic semiconductor laser on silicon

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Organic semiconductors combine novel semiconducting optoelectronic properties with simple processing from solution. Their low temperature processing, and strong visible light emission complement the properties of silicon opening up the possbility of hybrid optoelectronics. Considerable progress has been made in the development of organic semiconductor lasers and optical amplifiers. The materials have broad emission spectra, can give strong gain and be simply patterned by soft lithographic techniques to make distributed feedback lasers. Making such a laser on silicon is challenging because of the high refractive index and strong absorption of the silicon. We have addressed this problem by developing polymer distributed Bragg reflector lasers on a silicon on insulator substrate.

Preparation and characterization of ZnO particles embedded in organic-inorganic planar waveguide by sol-gel route

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Polymer-based photonics materials are now emerging as a revolutionary photonics technology promising advances in performance, reductions in cost and improved ease of manufacture.

At the same time nanocomposite materials are of growing interest particularly for their potentials practical applications in various photonics and electronics devices.

In this paper we present the preparation and the optical-spectroscopic characterizations of an organic-inorganic planar waveguide.

In particular ZnO particles, synthesized by sol-gel route, were embedded in a polymeric matrix as (3-glycidoxilpropil)trimethoxysilane and by means spin-coating technique the planar waveguides were prepared.

Refractive index and thickness of the waveguides were measured by m-line apparatus. The waveguide realized present a negligible birefringence and an attenuation coefficient less than 1 dB/cm.

Photoluminescence measurements indicate the present of a UV emission at about 400nm due to the Zn-O-Si interface state. This luminescence peak may find application in phosphors or as sensitizers.

Cadmium telluride: a silicon-compatible optical material as an alternative technology for building all-optical photonic devices

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Cadmium Telluride (CdTe) is a II-VI semiconductor that exhibits an interesting optical behaviour: a high index of refraction (2.74 at wavelengths around 1.55 µm), which allows for a strong confinement inside the material; a high Kerr coefficient (n2=5.23x10-13 cm2/W at 1.55 µm [1]), and low two-photon absorption, which can be made theoretically negligible by properly doping the material with Zinc. Thus, it seems feasible to use CdTe layers over a low-index substrate (in the same way that it is done with Silicon-on-insulator) to create highly-compact all-optical devices with a nonlinear performance better than that provided by Silicon. In fact, the optical properties of the CdTe material are similar to those of Gallium Arsenide compounds, with the advantage that it could be expected that CdTe layers could be processed in an intermediate step of a CMOS manufacturing line. In this work, some results on the use of CdTe as core material for the development of all-optical photonic devices are reported, including the design of waveguides for strong field confinement, technological processes to grow CdTe on 6" or 8" wafers (suitable for high-volume manufacturing) and the fabrication and optical characterisation of optical waveguides with a CdTe core.

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6996-08, Session 2

Electron confinements effects in silver nanoparticles embedded in sodalime glasses

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Metal clusters of nanometer size are emerging materials used to improve the optical performances of photonic devices. They are in fact able to efficiently absorb and transfer large amounts of excitation energy to dopants dispersed in glassy matrix. This work deals with the study of silver nanoparticles embedded in sodalime glass. Silver dispersion in the host network at different concentrations was obtained by ion-exchange. Photoluminescence and absorption measurements were used to characterize the optical properties of the sodalime glasses. The chemical state of Ag, as well as its interaction with the host matrix, were investigated using XPS. Experiments show that silver condensates in nanoparticles whose dimensions depend on the Ag concentration. Effects of quantum confinements related to clustering are evidenced by the analysis of the core line, Auger and Valence Band features. Data from photoelectron spectroscopy well correlate with those obtained from optical measurements.

6996-09, Session 3

Circular grating resonators as candidates for ultra-small photonic devices

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Circular grating resonators could lead to the development of very advanced silicon-on-insulator (SOI) based nano-photonic devices. They are clearly beyond the current state of the art in terms of functionality, size, speed, and integration density. The photonic devices based on circular grating resonators are computationally designed, optimized and studied in their functionality using finite-difference time-domain (FDTD) method. A wide variety of critical quantities such as transmission and reflection, resonant modes, resonant frequencies and field patterns are calculated. Due to the computational size some of these calculations have to be performed on a supercomputer (e.g. parallel Blue Gene machine). Using the computational design parameters the devices are fabricated in SOI. First the devices are defined by electron-beam lithography and the pattern transfer is achieved in an inductively coupled reactive-ion etch process. Then the structures are characterized by coupling light in from a tunable laser with a tapered lensed fiber. As predicted from the simulations the measured transmission spectra exhibit a wide range of different type of resonances with Q-factors over 1000. Scanning near field optical microscopy (SNOM) measurements revealed the spatial intensity distribution of the modes within the circular grating. This information can be used in a next step for further device optimization.

6996-10, Session 3

Resonance narrowing in a two-ring resonator system

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High finesse ring resonator is a potential candidate for realizing many on-chip applications such as slow light structures, bio-chemical sensing, and all-optical switching. In the simplest configuration, where one microring is coupled to either one or two waveguide buses, a high finesse is possible only when both the round trip loss and the waveguide-ring coupling are kept small, with the former much smaller than the latter. This creates a practical problem because weak coupling coefficient is difficult to control as the coupling is exponentially dependent on waveguide-ring separation. Therefore it is desirable to have high finesse resonance in a more strongly coupled system.

We propose a system that consists of two mutually coupled rings (R1 and R2), with R1 coupled to two waveguide buses, that in principle can produce a finesse 2 orders of magnitude higher than the single-ring system. The finesse enhancement is maximum when R2 is twice the size of R1, in which the light is antiresonant in R1 and resonant in R2, creating the maximum light isolation in R2 from external waveguides. We experimentally verify this concept by fabricating Silicon-on-Insulator (SOI) microring resonator using deep-UV lithography in a CMOS-based process. The two-ring systems are fabricated with various sizes for R1 and R2 and 34% power coupling with the waveguides (moderate finesse). The measured transmission spectra are in good fit with theoretical calculations, and the optimum finesse enhancement obtained was about 14, which is in a good agreement with the theoretical prediction of ~15.8.

Silicon microspheres for optical modulation and switching applications

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Microspheres have been attracting the attention of the photonics community due to their high sensitivity and selectivity[1]. Microspheres, with their high quality-factor (Q-factor) morphology dependent resonances, are very sensitive to refractive index and size changes[1]. The perturbation of the microsphere morphology dependent resonances can be used for optical modulation and switching applications. Carier injection in microspheres causes a change of refractive index [2]. This change leads to the blue shift of the resonant wavelengths. Silicon with a refractive index of 3.5 is a suitable photonic material for optical modulation and switching applications.

In this work, the light is coupled to the silicon microsphere by means of optical fiber half coupler (OFHC) [3]. Two metal probes contact to the reciprocal sides of the silicon microsphere and different voltages are applied to these probes [4]. By varying the electric field across the silicon microsphere, the TE and TM elastic scattering spectra at 90o and 0o (transmission) using a tuneable incoming laser beam are investigated experimentally. In addition, the associated resonance shifts due to the refractive index change are examined. The experimental results are discussed in view of the theoretical calculations, which are obtained by the generalized Lorenz-Mie theory (GLMT) [5].

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Analysis of silicon-on-insulator (SOI) optical microring add-drop filter based on waveguide intersections

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Microdisk and microring based optical add-drop filters in SOI photonic wires can have bend radii as small as 2µm. Because of this compactness they are good candidates to be employed as a switching component for future WDM optical interconnections link in ULSI circuits. Usually such a link is constructed as a passive, square N_N network. A network with these layout requires the drop channel (on resonance) to continue in the straight arms, while the other channels (off-resonance) travel diagonally through the network. We have previously reported a design of an optical add-drop filter suitable for this purpose by incorporating two resonators into a right-angle waveguide intersection. In this work we analyse operation of such filters depending on different geometrical parameters e.g. resonator radii. The characterized structures show free spectral range (FSR) of 45nm and quality factor of about 1000. The extinction ratio reached -15dB and drop efficiency is close to 100%. A set of devices with different resonator radii between 1.8 and 2.1µm has been fabricated and evaluated, showing proper addressing of different resonant wavelengths. With this, we prove the possibility of realizing the highly integrated optical WDM routed network for on chip interconnections. The influence of other geometrical parameters such as waveguide or resonator width and gap separating waveguides from resonators is also investigated. Finally the design of highly integrated 4_4 optical network, occupying chip area smaller than 45_45µm2 is proposed.

6996-13, Session 3

Active optical micro-resonators seen as mesoscopic photonic atoms

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The widespread analogy between an optical micro-cavity and an atomic system stems from obvious spectral features. The sharp resonance of a high-Q resonator resembles very much that of an atomic line, except that its position and linewidth are determined by structural properties (output coupler, cavity length) at least as much as by the intrinsic properties of the underlying media.

The Transfer Function plays a key role in describing the spectral response of the system, be it linear or nonlinear, to an external excitation. It can be thought of as the exact structural counterpart of the Susceptibility that represents the collective optical properties of an atomic medium. Following a density matrix approach, the latter is classically described, around each resonance, by a Lorentzian. So is the Transfer Function: similar effects are obviously expected in terms of transmission, absorption or gain, dispersion, nonlinear saturation.

In the specific case of active resonators, the concept of Generalized Transfer Function, as derived from Extended Transfer/Scattering Matrix Formalism, provides us with an elegant way of further widening this analogy by taking internal sources into account explicitly. This semi-classical approach leads to an analytical self-consistent description of a steady-state single-mode laser oscillator, that holds continuously across threshold.

We shall focus on one-dimensional single-mode emitters with Fabry-Perot or ring geometry, seen either as isolated "photonic atoms", or as building blocks for cavity-coupled "photonic molecules". Spontaneous and stimulated emission, homogeneous and inhomogeneous broadening will be commented upon.

6996-14, Session 4

Challenging nano-scale stress evaluation in glassy and crystalline semiconductor heterostructures

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The piezo-spectroscopic (PS) effect, which may be defined as the shift in wavelength of a spectroscopic transition in a solid in response to an applied strain or stress, may occur both in crystalline and in amorphous structures, regardless of the particular spectroscopic transition involved, and independent of the specific mechanism of luminescence emission (i.e., including spectra generated from band gap transitions, substitutional impurities, optically active point defects, etc.). The PS effect, when monitored on electro-stimulated spectra in a scanning electron microscope, may enable the characterization of residual and applied stress fields on the nanometer scale. The PS effect, being a physical property of the studied material, should be calibrated case by case. Advanced electronic devices possess active areas of sub-micrometric dimensions, in many cases smaller than 100 nm. In the attempt of improving device reliability, we have recently developed an electro-stimulated probe for nano-scale residual stress assessments. In this paper, we show the feasibility of nano-scale stress assessments in the scanning electron microscope for selected paradigm semiconductor materials.

Technical Programme

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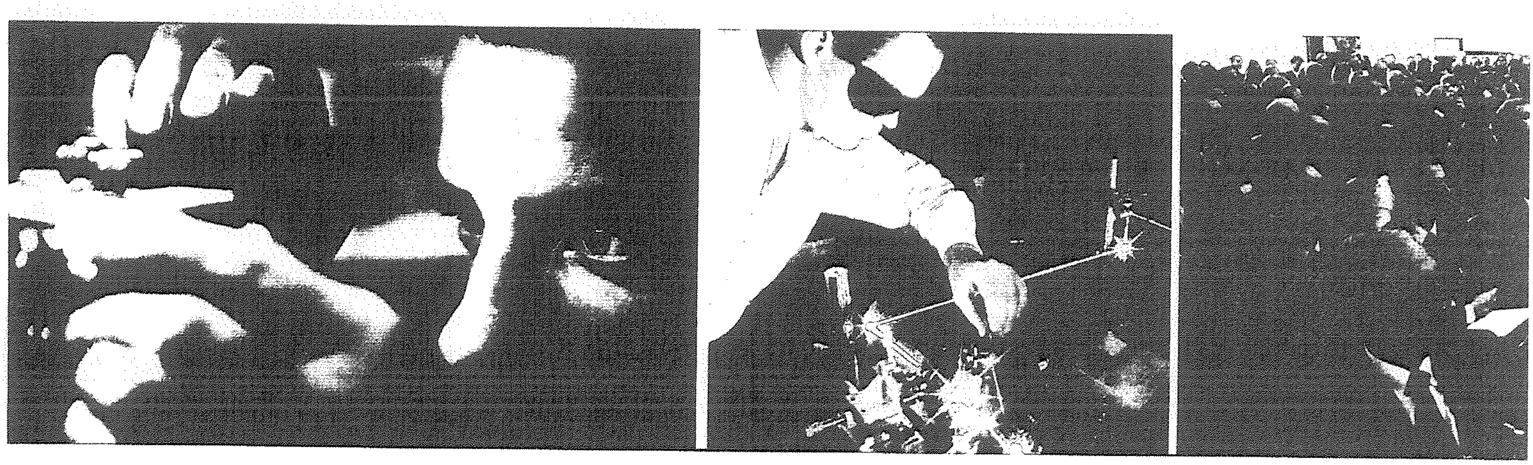

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