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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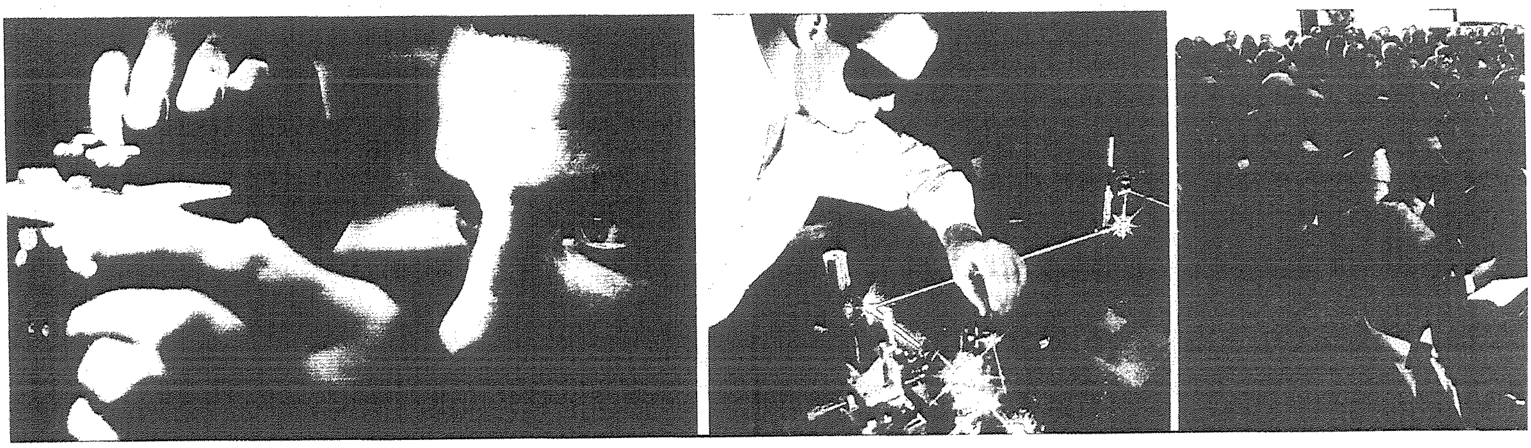

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