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OLEANDER ROOM

8:30 am–10:00 am
QWA, MICROCAVITY AND VERTICAL EMITTERS
Constance J. Chang-Hasnain, *Stanford University, Presider*

8:30 am (Invited)
QWA1 Combined quantum effects for electron- and photon-systems in semiconductor microcavities, M. Yamanishi, Y. Lee, *Hiroshima Univ., Japan.* We demonstrate experimental results on alteration of spontaneous emission and discuss a novel scheme for the generation of photon-number-squeezed state. **(p. 2)**

9:00 am
QWA2 Controlled atomic-like spontaneous emission from implanted erbium in a Si/SiO_2 Microcavity, A. M. Vredenberg, N. E. J. Hunt, E. F. Schubert, D. C. Jacobson, J. M. Poate, G. J. Zydzik, *AT&T Bell Laboratories.* We propose a model system for studying microcavity effects on spontaneous emission. Erbium-doped transparent Si/SiO_2 microcavities show emission intensity enhancement, peak narrowing, and lifetime changes. **(p. 4)**

9:15 am

QWA3 Quantum microcavities and quantum well excitons: an optimum system for strong optical coupling, Y. Arakawa, A. Ishikawa, M. Nishioka, C. Weisbuch, *Univ. Tokyo, Japan.* The strong light-matter coupling occurring between quantum well excitons imbedded in planar monolithic DBR-Fabry-Perot cavities and fundamental-mode photons is demonstrated. **(p. 6)**

9:30 am
QWA4 Threshold dependence on cavity length and mirror reflectivity in Fabry–Perot microcavity semiconductor lasers with high-contrast mirrors, D. L. Huffaker, D. G. Deppe, C. J. Pinzone, T. J. Rogers, B. G. Streetman, R. D. Dupuis, *The Univ. Texas at Austin.* Data are presented showing that short-cavity lasers are found to have significantly lower thresholds in comparison to long-cavity lasers, for otherwise nearly identical structures. **(p. 8)**

9:45 am
QWA5 Asymmetric gain in a vertical-cavity surface-emitting laser, F. Brown de Colstoun, C. W. Lowry, G. Khitrova, H. M. Gibbs, A. E. Paul, S. W. Koch, *Univ. Arizona;* T. M. Brennan, B. E. Hammons, *Sandia National Laboratories.* Light injected into a surface-emitting laser operating near threshold causes localized asymmetric gain modifications. The shift of the new peak is proportional to the injected power and reaches 36.2 GHz. **(p. 10)**

10:00 am–10:30 am COFFEE BREAK

OLEANDER ROOM

10:30 am–12:00 pm
QWB, MODULATORS: 1
David A. B. Miller, *AT&T Bell Laboratories, Presider*

10:30 am
QWB1 Interleaved-contact electroabsorption modulator using doping-selective electrodes with 25 °C to 95 °C operating range, K. W. Goossen, J. E. Cunningham, W. Y. Jan, D. A. B. Miller, *AT&T Bell Laboratories.* We demonstrate a MQW modulator with multiple stacked *p-i*(MQW)-*n-i*(MQW)-*p-* regions, such that each *i* region is electrically driven in parallel, allowing large Stark shifts at low voltages. For a 0–6-volt swing we achieve >22% reflectivity change from 25°C to 95°C. **(p. 14)**

10:45 am
QWB2 Functionally all-optical bistable *p-i-p-i-n* device with asymmetric GaAs/AlAs coupled QW absorption layers and an AlAs resistive layer, Yasunori Tokuda, Yuji Abe, Noriaki Tsukada, *Mitsubishi Electric Corporation, Japan.* A functionally all-optical bistable operation, based on the inner self-electro-optic effect, was achieved for a *p-i-p-i-n* device with asymmetric coupled QW absorption layers. **(p. 16)**

11:00 am
QWB3 Visible wavelength LEDs and reflection modulators with AlGaAs/AlAs QWs, B. Pezeshki, J. A. Kash, *IBM T. J. Watson Research Center;* Daxin Liu, S. M. Lord, J. S. Harris, Jr., *Stanford Univ.* Using the direct gap transition in indirect gap AlGaAs/AlAs QWs, we fabricate room temperature LEDs and Fabry–Perot reflection modulators operating at about 615 nm. **(p. 18)**

11:15 am
QWB4 Responsivity and excitonic electroabsorption in proton implanted GaAs/AlGaAs MQW modulators, T. K. Woodward, B. Tell, W. H. Knox, J. B. Stark, M. T. Asom, *AT&T Bell Laboratories.* Proton-implanted AlGaAs/GaAs MQW modulators exhibit suppressed responsivity, and increased saturation intensity, while continuing to exhibit excitonic electroabsorption. **(p. 20)**

11:30 am
QWB5 Nonlinear optical properties in infrared region in quantum well—an application of intersubband transitions, J. B. Khurgin, Shaozhong Li, *Johns Hopkins Univ.* Nonlinear optical properties of quantum wells, based on the intersubband transitions, have been examined theoretically. It is found that large susceptibility ($\chi^{(2)}$ and $\chi^{(3)}$) can be achieved. The comparison with interband transitions is also made. The implications for the design of nonlinear infrared optical devices are discussed. **(p. 22)**

11:45 am
QWB6 Intersubband transitions in high indium content InGaAs/AlGaAs QWs grown on GaAs with a graded InGaAs buffer, H. C. Chui, S. M. Lord, M. M. Fejer, J. S. Harris, Jr., *Stanford Univ.* We report observation of intersubband transitions in In(y)Ga(1–y)As (y = 03., 0.5)/AlGaAs QWs. The 1–2 intersubband transition energies of 311 meV and 351 meV are among the largest reported. **(p. 24)**

12:00 pm–1:30 pm LUNCH BREAK

OLEANDER ROOM

1:30 pm–3:00 pm
QWC, FUNDAMENTAL PROCESSES
Yoshihisa Yamamoto, *NTT, Presider*

1:30 pm (Invited)
QWC1 Quiet electrons, noisy photons: quantum statistical effects in waveguide transport, M. Büttiker, *Univ. Basel, Switzerland.* Quantum statistical effects of time-dependent electron-current and photon-intensity fluctuations at the contacts of few-channel, phase-coherent, multiprobe conductors and waveguides are analyzed. **(p. 28)**

2:00 pm
QWC2 Squeezing with input state of large-phase uncertainty, I. Lyubomirsky, M. Shirasaki, H. A. Haus, *Massachusetts Institute of Technology.* Squeezing in a nonlinear Mach–Zehnder interferometer is analyzed for a number state input. The same degree of squeezing is obtained with a number state as with a coherent state input. **(p. 30)**

2:15 pm (Invited)
QWC3 Quantum nondemolition measurement of photon number using a mesoscopic electron interferometer, Akira Shimizu, *Univ. Tokyo, Japan.* A quantum nondemolition photodetector using an electron interferometer composed of double quantum wires is discussed in addition to possible uses of other mesoscopic interferometers. **(p. 32)**

2:45 pm
QWC4 Semiconductor laser with dispersive loss: quantum noises and amplitude squeezing, R. F. Nabiev, *E. L. Ginzton Lab., Stanford Univ.* The quantum mechanical treatment of the amplitude and phase noise characteristics of internal and output light of semiconductor laser with dispersive loss element inside the resonator is presented. **(p. 34)**

3:00 pm–3:30 pm COFFEE BREAK

OLEANDER ROOM

3:30 pm–5:00 pm
QWD, QUANTUM WELL LASERS
H. Temkin, *Colorado State University, Presider*

3:30 pm (Invited)
QWD1 Multiquantum barrier (MQB): is it a good spice for semiconductor laser performances?, K. Iga, *Tokyo Institute of Technology, Japan.* The multiquantum barrier (MQB) is a semiconductor superlattice which can reflect electrons by interference. In this paper we review the recent progress of MQB-loaded semiconductor lasers and tunneling diodes. **(p. 38)**

4:00 pm
QWD2 Optimum strained MQW structure in 680-nm AlGaInP laser diodes for low threshold and high power, T. Tanaka, S. Kawanaka, H. Yanagisawa, S. Yano, S. Minagawa, *Hitachi Ltd., Japan.* Reliable high-power operation of strained MQW AlGaInP LDs is achieved at wavelengths around 680 nm by using thin QWs with large compressive strain. This suppresses the increase in threshold current and the red-shift of oscillation wavelength. **(p. 42)**

4:15 pm
QWD3 Narrow linewidth long wavelength phase-locked laser array with mode controlling grating filter, Jie Dong, Shigehisa Arai, Tetsu Ikeda, *Tokyo Institute of Technology, Japan.* Narrow linewidth of 203 kHz in a narrow beam divergence (FWHM = 4.7°) GaInAsP/InP 1.5 μm wavelength phase-locked laser array with a mode controlling grating filter (GFA) has been achieved. **(p. 44)**

4:30 pm
QWD4 Highly nondegenerate (>1 THz) four-wave mixing in MQW laser structures, M. C. Tatham, G. Sherlock, C. P. Seltzer, *BT Laboratories, UK.* Highly nondegenerate four-wave mixing is used to investigate ultrafast carrier dynamic processes in strained and unstrained QW lasers, and their contribution to nonlinear gain. **(p. 46)**

4:45 pm
QWD5 Optical properties of tensile and compressively strained (GaIn)P-(AlGaIn)P MQWs, Martin D. Dawson, Geoffrey Duggan, *Sharp Laboratories of Europe, Ltd., UK.* (GaIn)P-(AlGaIn)P bulk and quantum well heterostructures, with (GaIn)P layers under both tensile and compressive strain on a GaAs substrate, have been studied by low temperature photoluminescence and photoluminescence excitation spectroscopy. **(p. 48)**

OLEANDER ROOM

5:15 pm
QPdP, POSTDEADLINE PAPERS
Larry A. Coldren, *Univ. of California Santa Barbara, Presider*

THURSDAY, MARCH 18, 1993

GRAND BALLROOM EAST

8:30 am–10:00 am
QThA, MICROCAVITY AND VERTICAL EMITTERS: 2
Kenichi Iga, *Tokyo Institute of Technology, Japan*

8:30 am (Invited)
QThA1 Microcavity VCSELs, J. L. Jewell, *Photonics Research Inc.;* A. Scherer, B. Van der Gaag, L. M. Schiavone, J. P. Harbison, L. T. Florez, *Bellcore.* Experiments lasing thresholds in sub-half-micron diameter microcavity VCSELs imply very low losses and validate the feasibility of ultralow threshold lasers. **(p. 52)**

9:00 am
QThA2 Threshold reduction of 1.3-μm GaInAsP/InP surface-emitting laser by a maskless circular planar buried heterostructure (PBH) regrowth, T. Baba, K. Suzuki, Y. Yogo, K. Iga, F. Koyama, *Tokyo Institute of Technology, Japan.* A newly introduced maskless PBH regrowth has improved the hetero-interface of buried tiny circular active region of GaInAsP/InP surface-emitting laser. The threshold current of 1.3-μm range BH-type device was reduced to 2.2 mA at 77 K under cw condition. **(p. 54)**

9:15 am (Invited)
QThA3 Pixels consisting of a single vertical-cavity laser-thyristor and a double vertical-cavity phototransistor, Hideo Kosaka, Ichiro Ogura, Hideaki Saito, Mitsunori Sugimoto, Kaori Kurihara, Takahiro Numai, Kenichi Kasahara, *NEC Corp., Japan.* Bi-directionally cascadable optical pixels comprising low-threshold (1 mA) high-efficiency (0.25 W/A) surface-emitting laser-thyristors and wide-bandwidth (50 Å) high-photocurrent-gain (230 A/W) double vertical-cavity phototransistors are described. **(p. 56)**

9:45 am
QThA4 Intensity modulation bandwidth limitations of vertical-cavity surface-emitting laser diodes, M. G. Peters, M. L. Majewski, L. A. Coldren, *UC-Santa Barbara.* A small-signal equivalent circuit model has been developed for vertical-cavity surface-emitting lasers enabling quantitative analysis of intensity modulation bandwidth limitations due to extrinsic and intrinsic components. **(p. 60)**

10:00 am–10:30 am COFFEE BREAK

GRAND BALLROOM EAST

10:30 am–12:15 pm
QThB, MODULATORS: 2
E. E. Mendez, *IBM T. J. Watson Research Center, Presider*

10:30 am
QThB1 Analog differential self-linearized QW self-electro-optic effect modulator, E. A. De Souza, L. Carraresi, G. D. Boyd, D. A. B. Miller, *AT&T Bell Laboratories.* This device gives a difference in two optical output powers linearly proportional to electrical or optical drive, allowing bipolar processing in novel image processing arrays. **(p. 64)**

10:45 am
QThB2 AlGaAs/InGaAs/GaAs MQW voltage tunable Bragg reflector with interdigitated contacts, O. Blum, X. Wu, K. Gulden, T. K. Gustafson, *UC-Berkeley;* J. E. Zucker, *AT&T Bell Laboratories.* We report the first tunable QW Bragg reflector with interdigitated contacts. This modulation scheme produces >12% change in reflectivity for only +1 volt applied. **(p. 66)**

11:00 am
QThB3 Large, low-voltage absorption changes and absorption bistability in novel, three-step asymmetric QWs, J. A. Trezza, M. C. Larson, S. M. Lord, J. S. Harris, Jr., *Stanford Univ.* We developed novel QW structures which use changes in overlap integrals to exhibit very large negative and positive differential absorption changes and absorptive bistability. **(p. 68)**

11:15 am
QThB4 High-contrast, all-optical GaAlInAs//AlInAs MQW reflection modulator at 1.3 μm, M. F. Krol, R. K. Boncek, *USAF Rome Laboratory;* T. Ohtsuki, G. Khitrova, B. P. McGinnis, H. M. Gibbs, N. Peyghambarian, *Univ. Arizona.* A high-contrast, all-optical GaAlInAs asymmetric reflection modulator at 1.3 μm has been demonstrated. An on/off contrast ratio exceeding 1000:1 has been achieved. The operating speed was measured and found to approach 1 GHz. **(p. 70)**

11:30 am
QThB5 Mixing of electronic states and control of optical transitions in asymmetric triple QW structures, N. Sawaki, S. Fukuta, H. Goto, *Nagoya Univ., Japan;* T. Suzuki, H. Ito, K. Hara, *Nippondenso Co., Ltd., Japan.* The resonance or the anti-crossing of electronic states enhances the variation of optical absorption and luminescence spectrum in GaAs/AlGaAs coupled triple QWs under electric fields. **(p. 72)**

11:45 am
QThB6 Saturation and carrier sweepout in electroabsorptive GaAs/GaAsAlAs MQW diodes, D. J. Goodwill, J. S. Massa, G. S. Buller, S. J. Fancey, *Heriot-Watt Univ., UK;* A. Wachlowski, *Alcatel Austria Elin Research Centre, Austria.* Saturation in the responsivity spectra of GaAs/GaAlAS MQW photodiodes at high intensity (40 kW/cm²) has been correlated with carrier sweepout times measured by time-resolved photoluminescence. **(p. 74)**

12:00 pm
QThB7 High contrast reflection electro-absorption modulator with zero phase change, J. A. Trezza, B. Pezeshki, M. C. Larson, S. M. Lord, J. S. Harris, Jr., *Stanford Univ.* We develop the theory for creating zero-chirp vertical-cavity modulators. A zero phase shift device which modulates reflectivity from 96% to 4% is presented. **(p. 76)**

12:15 pm–1:30 pm LUNCH BREAK

GRAND BALLROOM EAST

1:30 pm–3:00 pm
QThC, EXCITON AND CARRIER DYNAMICS: 1
Wayne H. Knox, *AT&T Bell Laboratories, Presider*

1:30 pm (Invited)
QThC1 Coherent exciton effects in quantum wells, E. O. Gobel, *Philipps-Univ. Marburg, Germany.* Coherent exciton dynamics and interaction in various quantum wells and superlattices is studied by means of femtosecond four-wave mixing spectroscopy. **(p. 81)**

2:00 pm
QThC2 Time-resolved optical orientation used to examine Coulomb screening and phase space filling in quantum well excitonic saturation, M. J. Snelling, P. T. Perozzo, R. Bambha, A. Miller, *Univ. Central Florida;* D. C. Hutchings, *Univ. Glasgow, UK.* Picosecond excite-probe measurements show that phase space filling and Coulomb screening contribute almost equally to excitonic saturation and give an electron spin relaxation time of 50 ps. **(p. 82)**

THURSDAY, MARCH 18, 1993—*Continued*

2:15 pm
QThC3 Quantum mechanical oscillations of the electron capture time in quantum wells, B. Deveaud, D. Morris, A. Regreny, *France Telecom, France;* M. Barros, P. Becker, *AT&T Bell Laboratories.* Resonances in electron capture are observed using femtosecond pump probe and luminescence for 60-Å well when one well level is 36 meV below the barrier. **(p. 84)**

2:30 pm (Invited)
QThC4 AC-Stark shift of the Fermi edge singularity in modulation-doped quantum wells, I. Brener, W. H. Knox, J. E. Cunningham, *AT&T Bell Laboratories;* D. S. Chemla, *UC-Berkeley.* We present the first observation to our knowledge of the AC-Stark shift of the Fermi-edge singularity in modulation-doped quantum wells and discuss the new phenomena observed in this regime. **(p. 86)**

3:00 pm–3:30 pm COFFEE BREAK

GRAND BALLROOM EAST

3:30 pm–4:45 pm
QThD, EXCITON AND CARRIER DYNAMICS: 2
Benoit Deveaud, *CNET, France*

3:30 pm (Invited)
QThD1 Femtosecond dynamics of room-temperature excitons in II–VI MQWs, Anthony M. Johnson, Philippe C. Becker, Donghan Lee, Miriam R. X. de Barros, Robert D. Feldman, Alan G. Prosser, Richard F. Austin, Robert E. Behringer, *AT&T Bell Laboratories.* Femtosecond pump–probe experiments yield the first direct measurement of the relative bleaching strength of room-temperature excitonic absorption by "cool" free e-h pairs and "cold" excitons. **(p. 90)**

4:00 pm
QThD2 Femtosecond dynamics of exciton gain in (Zn,Cd)Se/ZnSe quantum wells, M. Hagerott, J. Ding, A. V. Nurmikko, *Brown Univ.;* Y. Gan, D. Grillo, J. Han, H. Li, R. L. Gunshor, *Purdue Univ.* Femtosecond spectroscopy has been applied to characterize exciton energy relaxation and formation of gain in the ZnCdSe/ZnSSe quantum well at T = 77K and beyond. By both pump–probe spectroscopy and degenerate four-wave mixing, we show how a strongly inhomogeneous n = 1 HH exciton resonance permits rapid energy relaxation and the formation of population inversion in the quasi-2D exciton system, before the onset to an electron-hole plasma. **(p. 92)**

4:15 pm
QThD3 Femtosecond studies of ultrafast large-angle polarization rotation in GaAs/Al$_x$Ga$_{1-x}$As MQWs under uniaxial stress, M. Wraback, H. Shen, J. Pamulapati, M. Dutta, P. Newman, *U.S. Army Research Laboratory;* Y. Lu, *Rutgers Univ.* The pump–probe technique was used to measure the dynamic probe polarization rotation resulting from the bleaching of anisotropic exciton absorption in uniaxially stressed MQWs. **(p. 98)**

4:30 pm
QThD4 Fast optical switching and amplification in a MQW vertical microcavity, R. Raj, J. L. Oudar, M. Bensoussan, *France Telecom, France.* We demonstrate external beam amplification by stimulated emission in an optically excited vertical microcavity. A gain of 8 dB over a 2-THz spectral band with a switch-off <20 ps is obtained before the occurrence of laser emission. **(p. 100)**

6:00 pm–7:30 pm CONFERENCE RECEPTION (Quantum Optoelectronics)

7:30 pm INFORMAL DISCUSSION

GRAND BALLROOM EAST

8:30 am–10:00 am
QFA, WIRES AND DOTS
C. Weisbuch, *Thomson CSF-LCR, France, Presider*

8:30 am (Invited)
QFA1 Characterization studies and luminescence of quantum wires and dots, Jean-Yves Marzin, *CNET, France.* Abstract not available at press time. **(p. 107)**

9:00 am
QFA2 Effects of size fluctuation on the optical properties of very narrow InGaAs/InP QW wires, S. Nojima, M. Notomi, M. Nakao, T. Tamamura, *NTT Opto-electronics Laboratories, Japan.* Quantum-wire size fluctuation is directly evaluated for the first time using atomic force microscopy; its effects on the photoluminescence spectrum and polarization anisotropy are discussed. **(p. 108)**

9:15 am
QFA3 Fabrication of GaAs quantum wires (~10 nm) by MOCVD selective growth, S. Tsukamoto, Y. Nagamune, M. Nishioka, Y. Arkawa, *Univ. Tokyo, Japan.* We fabricated GaAs triangular shaped quantum wires with ~10 nm lateral width by MOCVD selective growth technique, showing both photoluminescence spectra and high-resolution scanning electron micrographs. **(p. 110)**

9:30 am (Invited)
QFA4 GaInAs/InP long-wavelength quantum wires and boxes: fabrication technology and lasers, Shigehisa Arai, *Tokyo Institute of Technology, Japan.* Improvements in the regrowth process of a low-pressure OMVPE and the usage of p-type InP substrate have enabled a room temperature cw operation of GaInAs/InP quantum-wire laser. Approaches to high-performance lasers consisting of low-dimensional quantum well structures are presented. **(p. 112)**

10:00 am–10:30 am COFFEE BREAK

GRAND BALLROOM EAST

10:30 am–11:45 am
QFB, OPTICS AND TRANSPORT IN REDUCED DIMENSIONALITY
Manfred Pilkuhn, *Universitat Stuttgart, Germany*

10:30 am (Invited)
QFB1 Pros and cons of reduced energy relaxation at low dimensions for optoelectronics devices, H. Benisty, *Univ. Paris 6, France.* Reduced electron relaxation in quantum boxes and unperfect quantum wires explains their degraded optical properties but should improve dramatically the performances of intersubband infrared devices. **(p. 116)**

11:00 am
QFB2 Thermal and coherent carrier escape from QWs in an electric field, A. M. Fox, R. G. Ispasoiu, *Univ. Oxford, UK;* C. T. Foxon, *Univ. Nottingham, UK.* We identify coherent tunneling and thermal carrier escape mechanisms in electrically biassed GaAS/$Ga_{0.67}Al_{0.33}As$ QWs by the temperature dependence of the photocurrent I–V curves. **(p. 118)**

11:15 am
QFB3 Temperature dependence of electron and hole emission rates from a single QW with asymmetric barriers, R. P. Bambha, M. J. Snelling, P. Li-Kam-Wa, A. Miller, *Univ. Central Florida;* J. A. Cavailles, D. A. B. Miller, J. E. Cunningham, *AT&T Bell Laboratories.* Laser excite-probe measurements are used to determine thermionic emission rates as a function of temperature and electric field in a *p-i-n* doped waveguide. **(p. 120)**

11:30 am
QFB4 Optical nonlinearities associated with piezo-electric field screening in [111] strained-layer InGaAs/GaAs QWs, Arthur L. Smirl, D. S. McCallum, A. N. Cartwright, Thomas F. Boggess, *Univ. Iowa;* T. S. Moise, L. J. Guido, R. C. Barker, *Yale Univ.;* B. S. Wherrett, *Heriot-Watt Univ., UK.* We show that measurements of nonlinearity enhancements in strained [111] MQWs are due to screening by long-lived carriers, not in-well screening. **(p. 122)**