

[Room/Salle : Ballroom A]

Chair: M. Thewalt, SFU

MO-A9-1

10h00

Dilute Nitride Multiple-Quantum-Well Light Source for Optical Coherence Tomography*, **Scott Webster**¹, D.A. Beaton¹, E. Nodwell¹, T. Tiedje¹, E.C. Young¹, N.R. Zangenberg¹ and A.F. Umyskov², ¹ *University of British Columbia* and ² *Zecotek Innovations* — Optical coherence tomography (OCT) is an emerging medical imaging technique that is presently limited by the lack of an inexpensive light source of suitable brightness, with a wide spectrum (>100nm) in the near infrared (800-1500nm). We are exploring a new type of semiconductor light source, based on $\text{Ga}_{1-y}\text{In}_y\text{N}_x\text{As}_{1-x}$ dilute nitride multiple-quantum-well structures, that has the potential to solve this problem. Our design concept involves an optically pumped semiconductor waveguide device consisting of a series of de-coupled quantum wells of differing composition to achieve the necessary spectral range. In order to maximize the brightness, the source will be operated at low temperature (100K), in a super luminescent mode. Dilute nitride quantum wells are ideally suited to this application as a wide range of quantum well binding energies can be obtained while maintaining a lattice match with GaAs substrates. Samples containing GaInNAs quantum wells have been grown at 450C by RF plasma assisted molecular beam epitaxy with and without a Bi surfactant^[1]. The photoluminescence spectra of these samples have been measured as a function of temperature from 20-300K for both pulsed and CW excitation. In and N concentrations ranged from 3-28% and 0-1% respectively with quantum well emission wavelengths from 820 to 1160nm. Changing the temperature and pump wavelength controls the distribution of carriers in the wells and the shape of the emission spectrum. A three-quantum-well structure has been fabricated with an emission spectrum centred at 1000nm with 110nm FWHM at 100K.

1. S. Tixier *et al.*, *J Cryst Growth* **251**, 449 (2003).

* This work is being supported by NSERC.

MO-A9-2

10h15

Clustering of Ga on GaAs (100)*, **Kelly A.L. Shorlin** and M. Zinke-Allmann, *University of Western Ontario* — Thin film formation is an important field of study both for the fundamental physics and the technological applications. In many systems the thermodynamic equilibrium is clusters on the substrate rather than the formation of a uniform film and the study of the growth parameters is needed to determine the conditions which result in film formation. An overview of clustering of Ga on GaAs (100) is presented. A shape cycle between round and rectangular clusters is observed and the thermodynamics driving this cycle is discussed. The cluster size and spatial distributions are determined and compared to theoretical predictions.

* This work is being supported by University of Western Ontario.

MO-A9-3 10h30

Change in Photoluminescence Spectrum of Infrared Coupled Multiple Quantum Wells*, Hadi Rastegar-Moghaddam¹, Jochen Meyer¹ and Shane Johnson², ¹University of British Columbia and ²Arizona State University — Change in the photoluminescence (PL) spectrum of multiple quantum wells (MQW) under the influence of intense infrared (IR) laser was investigated. Two Al_xGa_{1-x}As/GaAs MQW samples, one symmetric and one asymmetric, were designed in such a way that their two conduction subbands would have an energy difference close to CO₂ laser that used as source of IR field. The samples were then grown by Dr. S. Johnson and his colleagues at the MBE laboratory of the Arizona State University. Using an amplified, frequency doubled Nd:YAG laser pulse, electrons were excited to the conduction band and with the help of CO₂ laser light the two conduction subbands were IR-coupled to each other. Synchronization of visible and IR laser was achieved by designing a special electronic circuit. The samples were placed at the end of cold finger of a cryostat that was kept in 77 K. Collected PL light was sent to a monochromator and the desired wavelength was guided to a photomultiplier tube (PMT). Using an integrator and computer the collected data were stored in specified files. First the symmetric sample was used and alteration of PL spectrum was investigated. For this sample because of parity, only transition from the first conduction subband (E1) to the first heavy hole valence subband (HH1) was allowed (E1-HH1 emission). To our knowledge for the first time the doublet structure in PL spectrum of QW in presence of IR fields was observed. For the asymmetric sample both e1-hh1 and e2-hh1 were allowed and in experiment both of them were analyzed. Again for the first time "emission hole" or "dark line" effects for e2-hh1 emission were observed. Also the effects of detuning, to positive and negative energy shifts and the relationship between the peak of PL spectrum and the intensity of IR laser were studied and compared to the theory.

* This work is being supported by NSERC.

MO-A9-4 10h45

Controlled Modification of Quantum Heterostructures by Ion Implantation Induced Defects*, Francois Schiettekatte¹, M. Chicoine¹, S. Chevobbe², D. Barba², V. Aimez², C. Dion³, P. Desjardins³, S. Raymond⁴, ¹Université de Montréal, ²Université de Sherbrooke, ³École Polytechnique de Montréal and ⁴Conseil National de Recherche du Canada — Defects generated by low energy ion implantation can be used to controllably blueshift the emission wavelength of InP-based heterostructures intended for optoelectronic applications. Results obtained for both quantum well and self-assembled quantum dot structures are presented and compared. The quantum well structures, grown by chemical beam epitaxy, consist of a lattice-matched 5 nm InGaAs quantum well in between 20 nm InGaAsP barriers on InP(001). P and As ions are implanted at 200 keV in the 1- μ m-thick InP cladding layer. Intermixing starts to be observed during thermal annealing at temperatures about 50°C below that for thermally induced intermixing (~700°C). The maximum blueshift (~100 nm) is obtained for ion fluences above 1x10¹⁴ at/cm² and implant temperature of 200°C. While intermixing only occurs at elevated temperatures, channeling measurements after implantations at 200°C indicate a long dechanneling tail, attributed to a significant in-depth diffusion of the defects during the implantation. The quantum dot structures consist of self-assembled InAs quantum dots, 3-5 nm thick and 18-42 nm in diameter, grown by metal-organic chemical vapour deposition on InP(001), capped with 200 nm InP, and implanted with 30 keV P ions. This time, a fluence of 1x10¹² P/cm² and annealing temperatures of only 500°C are sufficient to induce a 370 nm blueshift, the quantum dots then emitting at a wavelength close to that of their wetting layer. This blue shift can namely be explained by an optimal ratio between the inter-diffusion length and the structures size, and a three-dimensional geometry for which diffusion produces more intermixing. Still, these results give an important insight into the role played by ion implantation generated defects at relatively low temperature in InP-based structures.

* This work is being supported by CRSNG & FQRNT.

11h00 Coffee Break / Pause café**MO-A9-5 11h30**

Tailoring the Dimensionality of Gold Chains on Silicon, Mark Gallagher¹, Jason Crain², Jessica McChesney², Fan Zheng², Franz Himpsel², Paul Snijders³ and Steve Irwin⁴, ¹Lakehead University, ²University of Wisconsin-Madison, ³Delft University, The Netherlands and ⁴Naval Research Laboratory, Washington — For observing the exotic properties predicted for electrons in one-dimension, it is desirable to have one-dimensional solids with tunable electronic properties. We have explored gold atom chains on stepped silicon surfaces using a combination of scanning tunneling microscopy and angle-resolved photoemission^[1]. It is shown that the interchain coupling and the band filling can be adjusted systematically by varying the step spacing via the tilt angle from Si(111). Vicinal Si(111) surfaces with odd Miller indices, such as Si(335), Si(557), Si(553), Si(775), and others, form regular chain structures upon deposition of a fraction of a monolayer of gold. These chains exhibit metallic bands with nearly one-dimensional Fermi surfaces. From a tight binding fit to the data we find that band filling and inter-chain coupling can be varied from an intra-/inter-chain coupling ratio of 10:1 to >70:1. These findings suggest that self-assembled atomic chains represent a highly-flexible class of solids that approach the one-dimensional limit.

1. Crain *et al.*, *Phys Rev B* **69**, 125401 (2004).

MO-A9-6 11h45

STM of Gold Induced Chains at Stepped Silicon Surfaces, Laura Pedri, Mark Gallagher and Laura Topozini, *Lakehead University* — It has been predicted for some time that electrons confined to move in a single dimension will exhibit exotic behaviour. Recently, it has been demonstrated that gold induced chains on vicinal Si(111) may provide a model system with which to investigate many of these predictions^[1]. These photoemission experiments have shown that the chain structures exhibit metallic bands with highly 1-d Fermi surfaces. To complement k-space measurements, we have used scanning tunneling microscopy to investigate the real space atomic and electronic properties of several gold induced chains. Structures with different chain spacing are produced by varying the miscut angle and gold coverage. For example, the evaporation of 0.25 ML of gold onto a Si(775) surface produces chains running along the [110] direction spaced 2.13 nm apart.

1. Crain *et al.*, *Phys. Rev. Lett.* **90**, 176805 (2003).

MO-A9-7 12h00

GISAXS Characterization of Nanostructures in Glancing Angle Deposited Films*, Gisia Beydaghyan¹, K. Robbie¹, D. Schneider² and M.A. Singh¹, ¹Queen's University and ²Brookhaven National Laboratory — The grazing incidence small angle x-ray scattering (GISAXS) technique was used to probe the nanostructure of glancing angle deposited (GLAD) silicon thin films. GLAD is a fabrication technique that combines oblique vapor incidence with dynamic control of substrate motion to make possible the design and engineering of new materials with tailored structural details at the nanometer scale. The films of interest have been characterized using scanning electron microscopy and are known to exhibit pillar-like structures. GISAXS measurements were used for determination of pillar spacing, porosity, and average thickness. Synchrotron GISAXS measurements were performed at beamline X12B of the National Synchrotron Light Source (NSLS) of Brookhaven National Laboratory. The data were corrected for background and refraction effects, and clearly show sample scattering superimposed on the so-called Yoneda peaks from the film-substrate interface. Scattering in the direction parallel to the sample surface (q_y) indicates the presence of an interaction peak while scattering perpendicular to the sample surface (q_z) exhibits Bragg-like peaks due to density variation in the sample thickness. The GISAXS data are used to complement and extend existing information on the GLAD samples obtained from electron microscopy and ellipsometry measurements.

* This work is being supported by NSERC.

MO-A9-8 12h15

Damage in Self-Implanted Si: Channeling Compared to Nanocalorimetry, R. Karmouch, J-F. Mercure, Y. Anahory and F. Schiettekatte, *Regroupement Québécois sur les Matériaux de Pointe (RQMP)*, Département de physique, Université de Montréal — Nanocalorimetry measurement of the ion-implanted defect dynamics in polycrystalline Si is presented. 30 keV Si⁻¹⁵ keV Si⁻ and 15 keV C⁻ implantations have been performed at fluences ranging from 6.10¹¹ to 8.10¹⁴ Si/cm², and the heat released as a function of temperature during scans between 30 and 450°C are presented. It is shown that the heat released has the same shape in all cases, indicating that kinetics of ion implantation defects annealing is independent of dose and implantation energy. It is also shown that the heat release starts to saturate around a fluence 1.10¹⁴ Si/cm² while for similar fluences, the damage in mono-crystalline Si is far from being saturated, according to channeling measurements. This would imply that further lattice disorder does not occur at the expense of more stored energy. The effect of changing of the fluence rate and time evolution on the released heat is also discussed.

12h30 Session Ends / Fin de la session