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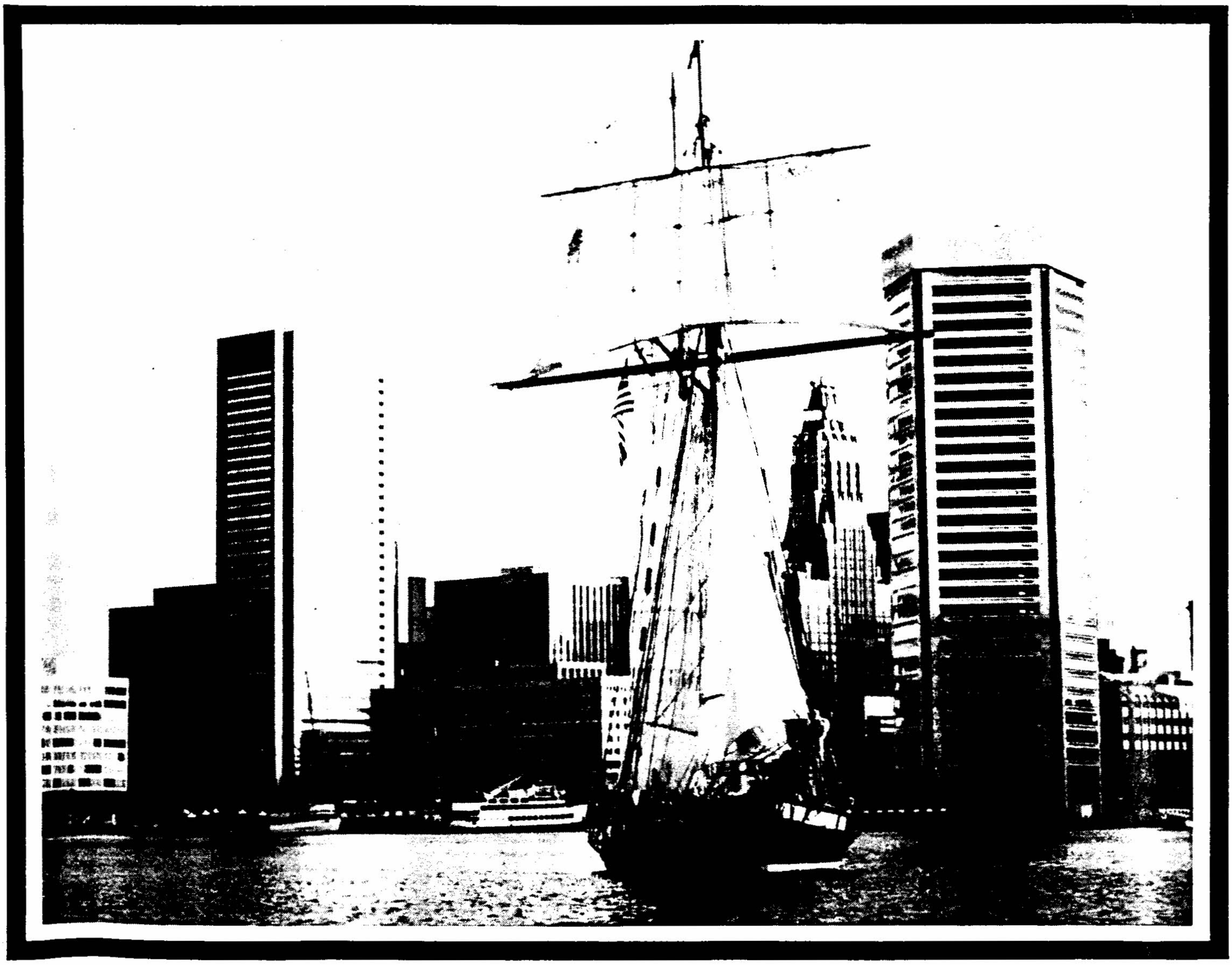

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March 1985

trinsic material. Detailed numerical modeling of these capacitance measurements have also been carried out and have allowed us to identify the magnitude of the moblity edge variation and the the role of interface states in the transition region. The relationship of our results to various "superlattice" structures in a-Si:H films will be discussed.

* Work at Oregon supported by NSF Grant DMR-8207437.

15:30

NE 11 Persistent Photoconductivity in a-Si:H/a-SiN$_x$:H Layered Structures*., S.C. AGARWAL** and S. GUHA, Energy Conversion Devices, Inc. -- A persistent photoconductivity effect (PPC), which lasts for many minutes at room temperature after a brief exposure to light, is observed in multiple thin layers of alternating a-Si:H and a-SiN$_x$:H. In addition, the samples in dark are found to get polarized upon application of low electric fields, parallel to the layers. The depolarization takes several minutes at 300K. These effects become larger as the number of layers are increased. However, the largest PPC observed in these layers is much smaller than that reported for amorphous doping multilayers. Our results are explained in terms of deep traps at the interfaces.

* Submitted by S.J. Hudgens

** On leave from Indian Institute of Technology, Kanpur, India

15:42

NE 12 High Depth Resolution RBS Applied to Plasma-deposited a-Si:H/Nitride Interfaces. J. R. ABELSON,* C. C. TSAI** and T. W. SIGMON, Stanford Electronics Labs — A multilayer structure based on plasma-deposited a-Si:H and Si$_3$N$_4$ will achieve quantum well effects only if the interfaces can be made sharp relative to the layer thicknesses of ~ 10 – 400 Å. We have examined the interfaces using grazing exit angle RBS/channeling of ^{4}He$^+$. We have reduced both geometric and electronic noise, optimized our geometry and predicted a constant 35 Å resolution from the surface to a depth of 250 Å. Our measurements resolved both Si and N scattering from 100 Å thick layers as rectangular spectra with a 35 Å resolution. For nitride deposited on a-Si:H the Si signal changes abruptly. By contrast, silicon deposited on nitride shows an interface gradation, consistent with the observation that NH$_3$ has a long residence time in the reactor following nitride growth. Graded interfaces with intentionally added compositional steps have also been studied. The effect of the observed asymmetry, depending on the order of deposition, on the properties of the a-Si:H/nitride interfaces will be discussed.

*Supported by the NSF-MRL Program through CMR at Stanford.

**Xerox Palo Alto Res. Ctr.

15:54

NE 13 Space Charge Doping in a-Si:H np Superlattices. I. Chen, Xerox Webster Research Center.—The potential distributions and the quantum mechanics of electrons in doping (np) superlattices are investigated theoretically. It is shown that the interlayer barrier height decreases with the layer thickness as a consequence of space charge doping. Thus, there exists an optimum thickness for carrier confinement. In a-Si:H np superlattices, this thickness is found to be in the range of several tens of nm, and is nearly an order of magnitude larger than the thickness of a-Si:H compositional superlattices (e.g. a-Si:H/SiN$_x$) in which the quantum effect becomes significant. Yet, this is consistent with the observation of persistent photoconductivity in a-Si:H np superlattices of this thickness.[1] The analysis attributes the large difference between the critical thicknesses in the two types of superlattices to the different effects of space charge doping on the barrier height.

1.J.Kakalios, H.Fritzsch and K.L.Narasimhan, Conf. on Optical Effects in Amorphous Semiconductors, Snowbird, Utah, 1984

16:06

NE 14 Growth and optical properties of glassy chalcogenide multilayer thin films*. M. SANO, N.X. CHEN, J. ZEMEL, and S. RABII, Univ. of Penn. -- Multilayer amorphous chalcogenide thin films are prepared by successive spin coating from organic chalcogenide solutions[1], up to the thickness of 4 µm. The different layers in a single film are either the same or alternate between different chalcogenides. Transmission spectra in the visible range are measured for all films. The dispersion of the optical constants are given for the multilayer films of the same chalcogenide system.

[1] G.C. Chern and I. Lauks, J. Appl. Phys., 53, 6979 (1982); 54, 4596 (1983).

*Supported by AFOSR-84-0320

SESSION NF: SEMICONDUCTOR HETEROSTRUCTURES—PLASMONS AND IMPURITY EFFECTS

Friday afternoon, 29 March 1985
Room 301 at 13:30
S. J. Allen, presiding

13:30

NF 1 Layer Thickness and Composition Dependences of Deep Levels in GaAs/Ga$_x$Aℓ$_{1-x}$As and Si/GaAs$_{1-x}$P$_x$ Superlattices. JUN SHEN, SHANG YUAN REN, AND JOHN D. DOW, U. of Notre Dame* — The dependence of the deep trap energy levels in GaAs/Ga$_x$Aℓ$_{1-x}$As and Si/GaAs$_{1-x}$P$_x$ superlattices on the layer thicknesses as well as the alloy composition is predicted by using a super-cell method. It is found that some impurities, including bulk shallow-donor dopants, exhibit a shallow-deep transition: as layer thickness or alloy composition is varied, shallow traps become deep traps.

*Supported by the Office of Naval Research (Contract No. N00014-84-K-0352)

13:42

NF 2 Conduction Band Crossover Effects on Deep Levels in Ge/Aℓ$_x$Ga$_{1-x}$As and Si/Si$_x$Ge$_{1-x}$ Superlattices. D. A. VASQUEZ, S. Y. REN, JOHN D. DOW, U. of Notre Dame* — We report predictions of the deep impurity levels in superlattices of Ge/Aℓ$_x$Ga$_{1-x}$As and of Si/Si$_x$Ge$_{1-x}$. The calculations follow the general spirit of the Hjalmarson model of deep levels [1], which is known to give a good acount of the deep levels in bulk semiconductors. We display explicitly the dependences of the deep levels on alloy composition x and on the thicknesses of the two basic superlattice layers. Particularly interesting are the consequences of the conduction band crossover in Si/Si$_x$Ge$_{1-x}$, and the shallow-deep transition of some normally shallow levels into deep levels, caused by quantum confinement.

[1] H. P. Hjalmarson et al., Phys. Rev. Lett. 44, 810 (1980).

*Supported by the Office of Naval Research (Contract No. N0014-84-K-0352).

13:54

NF 3 Ground Impurity Level in GaAs-AlGaAs Superlattice†. LIDERIO IORIATTI , and RAPHAEL TSU‡ Instituto de Fisica e Quimica de São Carlos, Universidade de SãoPaulo, Brazil -- The binding energy of the ground level of an hydrogenic impurity in a GaAs-AlGaAs superlattice is investigated by means of a variational procedure which incorporates all the miniband states. This is acomplished by constructing a trial wave function consisting of an 1s hydrogenic state modulated by an unknown amplitude 0 which depends only on the distance along the axis of the superlattice. Upon integration over the transverse coordinates, the minimization of the expectation value of the total H leads to a differential equation for 0 which can be solved exactly for any square well potentials and impurity locations. It is found that for an isolated Q.W., our results are much larger than previously obtained where mixing of Q.W. states were neglected. For superlattices having widths of the minibands in the order of or larger than the binding energy itself, results are substantially different from those obtained for an isolated well of the same width.

* Also at Energy Conversion Devices, Inc. Troy,Mi 48084
\+ Supported in part by the ONR grant No. N00014-83-G-0140

14:06

NF 4 Hydrogenic Impurities in Quantum Well Wires. J. BROWN AND H. N. SPECTOR, IIT* - The binding energy of hydrogenic impurities in a quantum well wire has been calculated as a function of the width of the quantum well wire and the location of the impurity with respect to the axis of the wire. The calculations have been performed using a variational wave function which is a product of a ground state hydrogenic wave function with a wave function which takes into account the confinement of the electrons in the wire. For the confining potential used in our calculations we have used the models of either an infinite potential well or a finite potential well whose depth is determined by the discontinuity of the band gaps in the quantum well wire and its cladding. For the infinite potential well model, the binding energy continues to increase as the radius of the wire decreases while in the finite potential well model, the binding energy reaches a peak value as the wire radius decreases and then decreases to a value characteristic of the cladding. The binding energy also depends upon the location of the impurity in the wire and is a maximum when the impurity is located on the axis of the wire.

*Supported by ARO Contract DAAG29-84-K-0109

14:18

NF 5 Far Infrared Magneto-absorption of Hydrogenic Donors Confined in GaAs-$Al_{.3}Ga_{.7}As$ Quantum Wells. N.C. JAROSIK, E. CASTANO, Y.C. LEE, B.D. MCCOMBE, S.U.N.Y. at Buffalo, J. RALSTON and G. WICKS, Cornell.*-Far infrared magneto-absorption measurements have been performed on a 375Å GaAs-$Al_{.3}Ga_{.7}As$ multiple quantum well in which shallow donors (Si) have been selectively doped at the well edges. Reductions in the 1s-$2p^+$ transition energy are observed, in agreement with recent theoretical predictions; however near magnetic fields where the energy of the $2p^+$ state crosses the second subband, deviations are observed. These deviations are attributed to mixing of the $2p^+$ state of the lowest subband with states of the second subband due to a magnetic field component in the plane of the quantum well. The results are compared with a simple theoretical model.

*Partially supported by ONR and NRRFSS.

14:30

NF 6 **Theory of the Stark Effect* for Acceptors in Semiconductor Quantum Wells.** W. T. Masselink, H. Morkoç, and Yia-Chung Chang, U of Illinois at Urbana-Champaign -- We have calculated the energy of acceptors in semiconductor quantum wells in an electric field. The (variational) calculation includes the top four valence bands of the material using the muliband effective mass approximation. We find that the effect of large electric fields on the acceptor energy is similar to the hydrogenic Stark effect; in small fields, however, the Stark effect for the acceptor is significantly different than for the hydrogenic system. In quantum wells, a higher field is required than in bulk semiconductor for a given energy shift; this is due to the lifting of the p-like state whose coupling is responsible for the Stark shift. The position of the acceptor in the well is also important.

• Supported by AFOSR contract F49620-83-K-0021 and by the U. of Ill. Materials Research Laboratory under NSF-DMR-83-16981.

14:42

NF 7 Evidence of Resonant Impurity States in Semiconductor Quantum Well Structures from Raman Scattering. T.A.Perry* and R.Merlin*, U.of Michigan, B.V.Shanabrook† and J.Comas†, Naval Res. Lab.--We have used resonant inelastic light scattering to study electronic transitions in anti-modulation Si-doped GaAs/(AlGa)As quantum well structures. Spectra from 460Å and 238Å well width samples taken at low power densities (<10W/cm^2), and low temperatures (~2K) show a well resolved splitting of the $E_{0\to1}$ intersubband transition (~18cm^{-1} between peaks). A similar splitting is also observed for the $E_{0\to2}$ intersubband transition in the 460Å sample. Power and temperature dependence of spectra are consistent with assigning the doublets to free intersubband transitions and transitions involving donor levels derived from higher subbands, i.e., resonant impurity states. There is good agreement between the observed peak positions and recent theoretical results[1].

*Supported by ARO.
†Supported by ONR.
[1] C.Priester, G.Allan and M.Lannoo, Phys. Rev. B29 3404 (1984)

14:54

NF 8 Raman Scattering Studies of Acceptors in GaAs-(AlGa)As Multiple Quantum Wells. D. GAMMON* and R. MERLIN*, U. of Michigan, W.T. MASSELINK†, R.J. FISCHER† and H. MORKOC†, U. of Illinois--We report resonant Raman scattering experiments on anti-modulation (Be-doped) GaAs/(AlGa)As multiple quantum-well structures. Data obtained at low power densities show transitions involving low-lying acceptor states and also states bound to higher subbands. The spectra at high excitations exhibit structures associated with free-hole transitions. The latter results are in qualitative agreement with those recently reported by Pinczuk et al.[1]

*Supported by ARO
†Supported by AFOSR
[1] A. Pinczuk, H.L. Stormer, A.C. Gossard and W. Wiegmann, 17th Int. Conf. Semic., to be published.

15:06

NF 9 **The Role of Impurities in Sequential Phonon Emission in Heterostructure Tunnel Junctions.* C. HANNA and R. B. LAUGHLIN, Lawrence Livermore National Laboratory--Hickmott et at.[1] have recently reported the observation of sequential longitudinal optic phonon emission in the tunneling current of a heterostructure placed in a strong magnetic field. We propose that this effect is caused by electrostatic feedback between current-dependent trapped charge at impurity sites and the tunnel barrier. We will discuss experimental tests of this point of view.**

[1] T. W. Hickmott, P. M. Soloman, F. F. Fang, F. Stern, R. Fischer, and H. Moroc, Phys. Rev. Lett. 52, 2053 (1984).

***Work performed under the auspices of the U.S. Department of Energy by the Lawrence Livermore National Laboratory under contract number W-7405-ENG-48.**

15:18

NF 10 **Bound State of an External Impurity at a Semiconductor-Semiconductor Interface in the Presence of a Magnetic Field** P. R. Antoniewicz and D. M. Hollox, The University of Texas at Austin*-- Considering a GaAs and $Ga_{1-x}Al_xAs$ interface with an ionized impurity in the higher band gap material, an electron in the

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*****	Documento 1 de 1
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