THE BELL SYSTEM TECHNICAL JOURNAL
Vol. 55, No. 5, May–June 1976
Printed in U.S.A.

Abstracts of Papers by Bell System Authors Published in Other Journals

CHEMISTRY

Dielectric Anisotropy in Amorphous Ta_2O_5 Films. P. W. Wyatt, J. Electrochem. Soc., *122* (December 1975), pp. 1660–1666. The capacitance of Ta-Ta_2O_5 thin-film capacitors varies in an asymmetric way with dc electric field. This asymmetry suggests that an interface effect might be involved, but measurements with different oxide thicknesses show that at low temperature the interfaces are not the cause. Therefore, the asymmetry must be due to anisotropy in the bulk oxide, which is surprising in view of its amorphous structure.

The Diffusion of Ion-Implanted Arsenic in Silicon. R. B. Fair and J. C. C. Tsai, J. Electrochem. Soc., *122* (December 1975), pp. 1689–1696. Secondary ion mass spectrometry and differential conductivity measurements of implanted-diffused As layers in Si have been performed to study the diffusion and electrical quality of these layers. The effects of diffusion ambient and surface pile-up of As are discussed.

Osmium Dioxide Trifluoride OsO_2F_3: Synthesis and Some Properties. W. E. Falconer, F. J. DiSalvo, J. E. Griffiths, F. A. Stevie, W. A. Sunder, and M. J. Vasile, J. Fluorine Chem., *6* (December 1975), pp. 499–520. Osmium dioxide trifluoride, OsO_2F_3, has been synthesized for the first time. The yellow-green substance is isomorphous with one phase of OsO_3F_2, and a fluorine-bridged polymeric system is likely. The free molecule is polar, and disproportionates readily at temperatures required to obtain its mass spectrum.

ELECTRICAL AND ELECTRONIC ENGINEERING

The Gettering of Boron by an Ion-Implanted Antimony Layer in Silicon. R. B. Fair and P. N. Pappas, Solid State Electron., *18* (December 1975), pp. 1131–1134. Secondary ion mass spectrometry has been employed to reveal the gettering of implanted B by an annealed, implanted Sb layer. It is shown that the gettering of B is significant, and may be caused by electric-field-enhanced diffusion of the B as well as by solubility enhancement of the electrically-active Sb.

Heterojunction Band Discontinuities. J. L. Shay, S. Wagner, and J. C. Phillips, Appl. Phys. Lett., *28* (January 1, 1976), pp. 31–33. The discontinuity $\Delta E_c = 0.56$ eV in the conduction band edge at n-CdS/p-InP junctions is reported. This discontinuity and others are compared with photoemission data and with Van Vechten's extension of these data to many tetrahedrally coordinated semiconductors. Agreement between measured discontinuities and theoretical predictions is very good. Predictions are made for band parameters pertinent to interfaces involving $A^{II}B^{IV}C_2^V$ compounds with zinc blende, chalcopyrite, or wurtzite crystal structures.

Ion Milling (Ion-Beam Etching), 1954–1975: A Bibliography. D. T. Hawkins, J. Vacuum Sci. Technol., *12* (November/December 1975), pp. 1389–1398. The ion milling (ion-beam etching) process has recently been exploited for a wide variety of applications. This bibliography of 215 references attempts to collect references on ion milling and to classify them by application. A brief review of the process and an author index to the bibliography are included.

A Modified Novel Frequency Multiplication Technique. R. K. Even, IEEE Trans. Circuits Syst., *CAS-22* (December 1975), pp. 954–959. Langham proposed a frequency multiplier that uses two oscillators and a simple digital processor. The

multiplication factor of this multiplier is equal to the ratio of the frequencies of the two oscillators. The modification proposed here involves discarding one of the oscillators at the cost of adding to the complexity of the digital processor. One thus retains the advantages of the Langham circuit while getting rid of its main disadvantage: the direct dependence of the accuracy and stability of the multiplication factor on the tracking characteristics of two oscillators.

A Note on Painted Reflecting Surfaces. T. S. Chu and R. A. Semplak, IEEE Trans. Ant. Propag., *AP-24* (January 1976), pp. 99–101. Microwave depolarization in the process of oblique reflection from a painted surface has been found insensitive to the dielectric constant of the paint and not negligible for higher frequencies if polarization requirement is stringent. Approximate reflection coefficients suggest lenient tolerance for uniformity of paint layer on reflector antennas of large F/D ratio.

A Theory of Software Reliability and its Application. J. D. Musa, IEEE Trans. Software Eng., *SE-1* (September 1975), p. 312. A theory of software reliability is developed and its successful application to four projects described. The theory permits estimation before a project, and reestimation during test, of the amount and duration of testing required to achieve a specified reliability goal. Managers can use the estimates to predict schedules and monitor progress.

Transistors with Boron Bases Predeposited by Ion Implantation and Annealed in Various Oxygen Ambients. T. E. Seidel, R. S. Payne, R. A. Moline, W. R. Costello, J. C. C. Tsai, and K. R. Gardner, International Electron Devices Meeting, Technical Digest, IEEE, December 3, 1975, pp. 581–584. When integrated circuit bases are fabricated on ⟨001⟩ oriented Si using ion implantation, special annealing processes are required to avoid defect formation and transistor degradation. A systematic study which examines the transistor degradation and establishes margins for oxygen in the annealing ambient is described.

PHYSICS

The Molecular Cloud Sagittarius B2. N. Z. Scoville, P. M. Solomon, and A. A. Penzias, Astrophys. J., *201* (October 15, 1975), pp. 352–365. The structure of the Sgr B2 molecular cloud has been studied by detailed mappings of the CO, ^{13}CO, CS, and H_2CO (2-cm) transitions. The dynamics of the gas in the cloud are found to be dominated by large-scale systematic motions with velocity not a monotonic function of radius.

CW Tunable Laser-Sideband Generation From 5.5 μm to 6.5 μm by Light Scattering From Spin Motion in a Spin-Flip Raman Laser. V. T. Nguyen and E. G. Burkhardt, Appl. Phys. Lett., *28* (February 15, 1976), pp. 187–189. CW laser sidebands are generated at wavelengths tunable from ~5.5 μm to ~6.5 μm. Behavior of the power output of about 10 μW is described quantitatively by using the equivalence between four-photon mixing and Raman scattering from coherent spin motion in a spin-flip Raman laser. High-resolution spectroscopy with new source is shown by the spectrum of NH_3, which indicates a linewidth $\leqq 0.01$ cm^{-1}.

High-Performance Solar Cell Material: n-AlAs/p-GaAs Prepared by Vapor Phase Epitaxy. W. D. Johnston, Jr. and W. M. Callahan, Appl. Phys. Lett., *28* (February 1, 1976), pp. 150–152. Solar cells with measured sea-level-sunlight power-conversion efficiencies of 13 to 18% and areas of several cm^2 have been prepared by vapor-phase epitaxial growth of n-AlAs on p-GaAs substrates. Cells have an anti-reflective passivating anodically grown coating and have much improved stability in the laboratory atmosphere.

Optical and Electronic Properties of Thin $Al_xGa_{1-x}As$-GaAs Heterostructures. R. Dingle, Crit. Rev. in Sol. State Sci., *5* (1975), p. 585. A brief survey of very recent optical investigations of molecular-beam-grown multilayer $Al_xGa_{1-x}As$-GaAs structures in which layer thicknesses as small as 50 Å is given. Confined carrier quantum effects produce new detailed structures in the above-gap GaAs absorption spectra. Properties of the $Al_xGa_{1-x}As$-GaAs interface are discussed.

Optical Fiber Modes Using Stimulated Four Photon Mixing. R. H. Stolen and W. N. Leibolt, Appl. Opt., *15* (January 1976), pp. 239–243. Phase-matched, stimulated, four-photon mixing was used to excite separately and photograph all the modes of a 10-mode optical fiber. Measured mode intensities agreed well with intensities calculated for a step-index guide. Interactions between different Stokes:anti-Stokes pairs were also observed.

Optical Investigation of Stress in the Central GaAs Layer of Molecular-Beam-Grown $Al_xGa_{1-x}As$-GaAs-$Al_xGa_{1-x}As$ Structures. R. Dingle and W. Wiegmann, J. Appl. Phys., *46* (October 1975), pp. 4312–4315. From the analysis of exciton splittings and shifts in the 2K absorption spectra of central GaAs layers in molecular-beam-grown $Al_xGa_{1-x}As$-GaAs-$Al_xGa_{1-x}As$ structures, the magnitude and sign of the layer stress is deduced. Annealing at 850°C has little influence on the layer stress, although large changes in photoluminescence efficiency are observed.

Room-Temperature Operation and Threshold Temperature Dependence of LPE-Grown $In_xGa_{1-x}As$ Homojunction Lasers. R. E. Nahory, M. A. Pollack, D. W. Taylor, R. L. Fork, and R. W. Dixon, Appl. Phys., *46* (December 1975), pp. 5280–5282. $In_xGa_{1-x}As$ homojunction lasers prepared by liquid phase epitaxy have been operated from below 77°K to room temperature. Lowest thresholds were $J_{th} = 2000$ A/cm² at 77°K and 290,000 A/cm² at room temperature. The variation of threshold with temperature can be fit by either $J_{th} \sim T^3$ or $J_{th} \sim \exp(T/67°)$ above ~150°K, and by $J_{th} \sim T^{2.3}$ at lower temperatures.

Tunable CW Difference-Frequency Generation in Tellurium at ~11 μm. T. J. Bridges, V. T. Nguyen, E. G. Burkhardt, and C. K. N. Patel, Appl. Phys. Letters, *27*, No. 11 (December 1 1975), pp. 600–602. Difference frequency mixing in tellurium between a tunable CW spin-flip Raman laser at 5.3 μm and a 10 μm fixed frequency CO_2 laser has given CW tunable output near 11 μm. Spectroscopy of ammonia indicates a source linewidth ≤ 0.01 cm^{-1}. Use of other fixed frequency lasers could provide a high resolution CW tunable source from 5–30 μm.

SYSTEMS ENGINEERING AND OPERATIONAL RESEARCH

Time Variations and Harmonic Content of Inductive Interference in Urban/Suburban and Residential/Rural Telephone Plants. D. N. Heirman, IEEE Trans. Commun., *COM-23*, No. 12 (December 1975), pp. 1484–1495. The time variations and harmonic content of longitudinal (common-mode) interference present on a wide variety of telephone lines in both urban/suburban and residential/rural environments are presented. This data will aid telephone equipment designers to reduce adverse inductive interference effects of the telephone operating environment on their designs.

8311-4-4
D