Abstracts of Papers by Bell System Authors Published in Other Journals

CHEMISTRY

Analysis of the Air-Formed Oxide Film on a Series of Iron-Chromium Alloys by Ion-Scattering Spectrometry. R. P. Frankenthal and D. L. Malm, J. Electrochem. Soc., *123* (February 1976), pp. 186–191. Depth profiles were obtained for Fe-Cr alloys (5–25% Cr). Using suitable standards, atomic composition ratios were calculated as a function of depth. From variations of Cr/Fe with depth and with alloy composition, it is speculated that the distribution and bonding of cations differentiates stainless from non-stainless alloys or steels.

Electroetching of Platinum in the Titanium-Platinum-Gold Metallization on Silicon Integrated Circuits. R. P. Frankenthal and D. H. Eaton, J. Electrochem. Soc., *123* (May 1976), pp. 703–706. The periodically varying potential, which is applied to metallizations in 5 *M* HCl, was designed to overcome problems of platinum passivation and relatively high metallization resistances. The resolution of etched patterns is good using positive or negative photoresists. The process is applicable to etching of other metallizations on high-resistance substrates.

Kinetics of the Thermal Decomposition of $CaCO_3$ in CO_2 and Some Observations on the Kinetic Compensation Effect. P. K. Gallagher and D. W. Johnson, Jr., Thermochim Acta, *14* (March 1976), pp. 255–261. Dynamic and isothermal kinetic studies were made of the thermal decomposition of $CaCO_3$ in CO_2 atmosphere. Variations of activation energy with sample size and heating rate suggest thermal transport is rate determining. The linear relationship between activation energy and the log of the preexponential term is discussed.

Mechanism of Oxidation at a Copper-Polyethylene Interface. II. Penetration of Copper Ions in the Polyethylene Matrix. D. L. Allara, C. W. White, R. L. Meek, and T. H. Briggs, J. Polym. Sci.: Part A-1, Polym. Chem., *14*, No. 1 (January 1976), pp. 93–104. Two surface analysis techniques (Rutherford backscattering and surface composition by analysis of neutral and ion impact radiation) have been applied to the study of interfacial copper transport in the oxidation of polyethylene films over copper surfaces. The results clarify the roles of heterogeneous and homogeneous catalytic processes.

On Passivity of Iron and Its Alloys. R. P. Frankenthal, Boshoku Gijutsu, *24* (October 1975), pp. 537–545. This review assesses the current state of understanding of passivity of iron and its alloys, defines the areas of agreement and disagreement in the field, and poses the questions that must be answered to further our understanding.

Picosecond Recovery Dynamics of Malachite Green. E. P. Ippen, C. V. Shank, and A. Bergman, Chem. Phys. Lett., *38*, No. 3 (March 15, 1976), pp. 611–614. Using subpicosecond pulses from a mode-locked cw dye laser, we have studied ultrafast absorption recovery in the triphenylmethane dye malachite green after excitation to the first singlet. In methanol an exponential time constant of 2.1 ps is measured. As solvent viscosity is increased, recovery becomes slower and a two-component relaxation is evident.

COMPUTING

On the Sethi-Ullman Algorithm. S. Chen, Inter. J. Comp. Math., *5* (1975), pp. 37–55. A directed acyclic graph (dag) can be used to represent an arithmetic expression consisting of sequences of binary operations on arguments. The Sethi-Ullman algo-

rithm generates optimal object code for a machine with $N \geq 1$ registers and unlimited memory capacity when the dag is a binary tree. We define a subclass of dags, the 1-load binary dags, employing a tree-like grammar, and modify the Sethi-Ullman algorithm to include this subclass when $N = 2$ registers. The proof of optimality relies on the use of syntax directed translation schemas.

ELECTRICAL AND ELECTRONIC ENGINEERING

Asymptotic Theory of Scattering by a Rough Surface Progressing Over an Inhomogeneous Ocean. F. M. Labianca and E. Y. Harper, J. Acoust. Soc. Amer., *59* (April 1976), pp. 799–812. A general asymptotic theory of scattering by a moving rough surface is presented. The theory is valid for a slowly varying refractive index, and for ocean-surface wave heights that are small compared with the acoustic wavelength and the ocean-surface correlation length. In contrast with the Kirchhoff or physical optics approximation, this theory is valid when the acoustic wavelength and ocean-surface correlation length are of the same order.

Differential Addressing of Clusters of Changed Picture Elements for Interframe Coding of Videotelephone Signals. B. G. Haskell, IEEE Trans. Commun., *24* (January 1976), pp. 140–144. In a conditional replenishment coder for videotelephony only those picture elements (pels) which have changed significantly since the previous frame are transmitted.

Increased addressing efficiency for videotelephony results if clusters or changed pels are positioned not with respect to the beginning of the line, but with respect to another cluster in the previous line or previous frame which has already been transmitted. Results are given of computer simulations using digitally stored videotelephone signals which were carried out to evaluate such differential schemes.

Efficient, Lattice-Matched, Double-Heterostructure LED's at 1.1 μm from $Ga_xIn_{1-x}As_yP_{1-y}$. T. P. Pearsall, B. I. Miller, R. J. Capik, and K. J. Bachmann, Appl. Phys. Lett., *28* (May 1, 1976), pp. 499–501. The growth and operation of lattice-matched, double-heterostructure, $InP/Ga_{0.17}In_{0.83}As_{0.34}P_{0.66}/InP$ light-emitting diodes is reported. These diodes have an emission wavelength of 1.1 μm and quantum efficiencies of 4 percent.

Elastically Enhanced Nonradiative Recombination at $Al_xGa_{1-x}As$-GaAs Heterointerface. W. D. Johnston, Jr. and R. A. Logan, Appl. Phys. Lett., *28* (February 1, 1976), pp. 140–142. In the presence of an elastic strain gradient of order 10^{-5} μm^{-1}, the nonradiative recombination rate at an (LPE) $Al_xGa_{1-x}As$-GaAs heterointerface is observed to increase, reversibly, by as much as 100-fold.

Hopping Conductivity in C-Implanted Amorphous Diamond, or How to Ruin a Perfectly Good Diamond. J. J. Hauser and J. R. Patel, Solid State Commun. *18*, No. 7 (1976), pp. 789–790. The electrical properties of amorphous diamond layers produced by C implantation are similar to those of deposited amorphous carbon films. This suggests that amorphous C consists of a mixture of diamond and graphite bonds irrespective of the preparation method.

Low Frequency Transfer Efficience of *E*-Beam Fabricated Conductivity Connected Charge-Coupled Device. R. H. Krambeck, T. F. Retajczyk, and L. D. Yau, IEEE J. Solid-State Circuits, *SC-11* (February 1976), pp. 171–180. Theoretical calculations are made of low-frequency transfer inefficiency for the conductivity connected, charge-coupled device (C4D). The fabrication and testing of C4Ds with barrier lengths in the range 1.75 μm to 5 μm are described, and the measured transfer inefficiencies compare well with theoretical predictions.

Power Spectra Obtained From Exponentially Increasing Spacings of Sampling Positions. H. D. Helms, IEEE Trans. Acoust. Speech Signal Process, *ASSP-24* (February 1976), pp. 63–71. An estimate of the spectrum is based on the Laplace transform which is approximated at exponentially spaced samples and analysis frequencies. The numbers of samples and computations required for exponential spacing of samples and frequencies generally are less than those required for equidistant spacing.

Preparation of Thin Windows in Silicon Masks for X-Ray Lithography. C. J. Schmidt, P. V. Lenzo, and E. G. Spencer, J. Appl. Phys., *46* (September 1975), pp. 4080–4082. Thin Si windows approximately 1–4 cm in diameter and 1–5 μm thick are made for soft x-ray lithography using a rapid chemical etch process. Procedures are uncritical and lend themselves to semiautomated operation. Yield for the etching process alone is close to 100 percent.

Timing Recovery in Digital Synchronous Data Receivers. K. H. Mueller and M. Müller, IEEE Trans. Commun., *COM-24* (May 1976), pp. 516–531. A new class of fast-converging timing recovery methods for synchronous digital data receivers is investigated. Starting with a worst-case timing offset, convergence with random binary data will typically occur within 10–20 symbols. The input signal is sampled at the baud rate; these samples are then processed to derive a suitable control signal to adjust the timing phase. A general method is outlined to obtain near-minimum-variance estimates of the timing offset with respect to a given steady-state sampling criterion.

Wide-Band Partial Discharge Detector. E. A. Franke and E. Czekaj, IEEE Trans. Elec. Insul., *EI-10* (December 1975), pp. 112–6. A wideband (30 MHz) peak-voltage detector has been constructed for measuring partial discharges from high-voltage, power-separation filters. An inexpensive, low-resolution, amplitude-distribution analyzer can be assembled by combining several detectors for the special requirements of high-voltage dc laboratory investigations.

MATERIALS SCIENCE

Mechanical Properties at Elevated Temperature of CuBath* Electroplated Copper for Multilayer Boards. A. Fox, J. Test. Eval., *4*, No. 1 (January 1976), pp. 74–84. The mechanical properties of CuBath* electroplated copper, including creep, stress-relaxation, monotonic tensile properties, and cyclic strain ratcheting were studied as a function of temperature and plating thickness to provide design information as to the material response of PTHs in MLBs during differential thermal expansion and contraction. * Sel Rex Company, the Division of Oxy Metal Finishing Corporation.

PHYSICS

Combined Radiation and Developing Laminar Free Convection Between Vertical Flat Plates With Asymmetric Heating. J. R. Carpenter, D. G. Briggs, and V. Sernas, J. Heat Transf., *98* (February 1976), pp. 95–107. A numerical investigation of the interaction of radiation with developing laminar free convection in vertical parallel plate channels with asymmetric heating is presented. Radiation to the inlet-exit and the cooler opposing entrance wall alters the nonradiation results by reducing the wall temperature by as much as 50 percent.

Continuous Operation of 1.0-μm-Wavelength $GaAs_{1-z}Sb_z/Al_yGa_{1-y}As_{1-z}Sb_z$ Double-Heterostructure Injection Lasers at Room Temperature. R. E. Nahory, M. A. Pollack, E. D. Beebe, J. C. DeWinter, and R. W. Dixon, Appl. Phys. Lett., *28* (January 1, 1976), pp. 19–21. Double-heterostructure $GaAs_{1-z}Sb_z/Al_yGa_{1-y}As_{1-z}Sb_z$ injection lasers have been operated continuously at room temperature for the first time. Emission was near 1.0 μm. The lowest threshold current density observed was 2.1 kA cm^{-2} dc.

Effects of Buffer Gases on Optically Pumped CH_3F FIR Laser. T. Y. Chang and C. Lin, J. Opt. Soc. Amer., *66*, No. 4 (April 1976), pp. 362–369. The effects of buffer gases on the performance of a 496-μm, optically pumped CH_3F laser are studied both experimentally and theoretically. A 55-percent increase in output power can be obtained by adding *n*-hexane vapor to an equal amount of CH_3F.

4F Virtual Bound State Formation in $CeAl_3$ at Low Temperatures. K. Andres, J. E. Graebner, and H. R. Ott, Phys. Rev. Letters, *35* (December 29, 1975), pp. 1779–1782. Specific-heat and electrical resistivity measurements in $CeAl_3$ below 0.2 K reveal enormous magnitudes of the linear specific-heat term $C = \gamma T$ (γ = 1620 m/mole K^2) and the T^2 term in $\rho = AT^2$ (A = 35 $\mu\Omega$ cm/K^2). We conclude that the $4f$ electrons

obey Fermi statistics at low temperature because of the formation of virtual bound $4f$ states.

Laser Action at 12.812 μm in Optically Pumped NH_3. T. Y. Chang and J. D. McGee, Appl. Phys. Letters, *28*, No. 9 (May 1, 1976), pp. 499–501. Optical pumping of the aR(6,0) line of the ν_2 fundamental vibrational band of NH_3 has led to laser action on the aP(8,0) line at 12.812 μm of the same vibrational band. A 5-kW pulsed output has been obtained by using 1.5 MW of pump power at 9.294 μm from a CO_2 laser.

Modulation Spectroscopy at Non-Normal Incidence With Emphasis on the Vacuum-uv Spectral Region. D. E. Aspnes, C. G. Olson,* and D. W. Lynch,* J. Appl. Phys., *47* (February 1976), pp. 602–607. Expressions are given to analyze modulation spectra taken at non-normal incidence. These expressions are used to determine the optimum angle of incidence to maximize the signal-to-noise ratio. Significant improvements are shown to be obtained in the vacuum-uv spectral region by making measurements at relatively large angles of incidence. * Iowa State University.

New Nanosecond Continuum for Excited-State Spectroscopy. C. Lin and R. H. Stolen, Appl. Phys. Lett., *28* (February 15, 1976), pp. 216–218. A new nanosecond continuum is generated by nonlinear optical processes in fiber waveguides pumped with a 20-kW 10-ns dye-laser pulse of broad spectral width. The continuum bandwidth is several thousand cm^{-1} in the visible with a total power ~1 kW. This continuum is useful for nanosecond time-resolved excited-state spectroscopy.

Strength of 0.04-50-m Lengths of Coated Fused Silica Fibers. C. R. Kurkjian, R. V. Albarino, J. T. Krause, H. N. Vazirani, F. V. DiMarcello, S. Torza, and H. Schonhorn, Appl. Phys. Lett., *28*, No. 10 (May 15, 1976), pp. 588–590. Tensile strength measurements have been made on coated fused silica fibers at gage lengths up to 50 m. At gage lengths between 0.04 and 10 m, the average strength is essentially constant at about 5 GN/m^2 (700 ksi). At gage lengths greater than 20 m the length dependence becomes important and by 50 m the strength has decreased to about 2 GN/m^2 (300 ksi). The minimum strength recorded in the testing of samples taken continuously from a length of 1031.6 m was 0.43 GN/m^2 (64 ksi). A "weakest link" model appears to be obeyed.

Virtual Bound States of Pd in Cu, Ag, and Au, and of Pt in Ag. S. Hüfner, G. K. Wertheim, and J. H. Wernick, Solid State Commun., *14* (December 15, 1975), pp. 1585–1590. The positions and widths of the virtual bound states of Pd in Cu, Ag, and Au and of Pt in Ag have been measured by XPS. The spin–orbit splitting of the Pt state in Ag is comparable to the spectroscopic atomic value. The host lattice d-band structure is perturbed in the alloys.

SYSTEMS ENGINEERING AND OPERATIONAL RESEARCH

Combined Primal-Dual and Penalty Methods for Convex Programming. B. W. Kort and D. P. Bertsekas, Siam J. Contr. Optim., *14* (February 1976), pp. 268–294. We propose and analyze a class of combined primal-dual and penalty methods for constrained minimization which generalizes the method of multipliers. We provide convergence and rate-of-convergence analysis for these methods for the case of a convex programming problem. We prove global convergence in the presence of both exact and inexact unconstrained minimization, and we show that the rate of convergence may be linear or superlinear with arbitrary Q-order of convergence, depending on the problem at hand and the form of the penalty function employed.