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Positron Annihilation in Copper

K. White

W. H. Rickles

Thomas Listerman

Wright State University - Main Campus, thomas.listerman@wright.edu

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vacancies. The intensity of the Cd peak at 1.488 eV was found to increase with decreasing fluences in annealed samples supporting the interstitial substitutional diffusion model. These measurements have shown that depth resolved cathodoluminescence is an excellent nondestructive method for sharply defining damage layers in ion-implanted materials.

F 2 Electrical Transport Properties of High Purity Silicon. S.R. Smith, University of Dayton Res. Inst.^{*}, P.M. Hemenger and R.A. Green^{**}, Air Force Materials Laboratory. -- The most sensitive and direct method for evaluating high purity Si is by measuring the Hall effect and resistivity as functions of temperature. This approach permits the routine measurement of electrically active impurity concentrations in the range of $5 \times 10^{11}/\text{cm}^3$ (i.e. about 0.01 part per billion). The Si is purified by multiple-pass vacuum float zoning which leaves B as the dominant impurity. Electrically guarded van der Pauw¹ apparatus is employed that permits the collection of data to temperatures below 20K where the sample resistance exceeds 10^{12} ohms. The Si is p-type with room temperature resistivities typically in excess of 10^4 ohm-cm. The hole mobility at low temperatures shows no detectable impurity scattering effects and has a value of about $2 \times 10^5 \text{ cm}^2/\text{V-sec}$ at 18K. The general experimental problems (including the formation of ohmic contacts) associated with measuring a highly resistive semiconductor will be described. The extraction of material properties such as acceptor and donor concentrations as well as carrier scattering mechanisms will be discussed.

^{*}Supported by Air Force Contract No. F33615-76-C-5269

^{**}Visiting Scientist

¹P.M. Hemenger, Rev. Sci. Instrum. **44**, 698(1973).

F 3 Kinetics of the ω -Phase Transformation in Beta-III Titanium. JIINJEN SUE, J.F. THOMAS, JR., and H.M. SIMPSON, Wright State U. -- The formation of omega phase in commercial Beta III titanium alloy (Ti-11.5 Mo-6Zr-4.3Sn in nom. wt.%) is being studied using in situ elastic modulus measurements. Young's modulus is determined from the resonant frequency of an electrostatically driven cantilevered beam during ω -forming heat treatments. The kinetics of the beta-to-omega transformation in solution treated and quenched specimens have been studied during isothermal annealing over a temperature range of 200° - 375°C. Preliminary analysis indicates that the kinetics can be described by the empirical Austin-Ricketts equation. For specimens solution-treated above the beta transus temperature ($\approx 750^\circ\text{C}$), rapid nucleation of omega is observed during heating to the transformation temperature.

F 4 Electrical Resistivity Studies of Phase Transformations in Vanadium-Hydrogen Alloys. M. W. PERSHING^{*} and J. F. THOMAS, JR., Wright State U., and R. C. BOWMAN, JR., Mound Laboratory. ^{**} α -Phase transformations in V_x alloys with x = .40 to .85 are being investigated using electrical resistivity. Preliminary results for compositions x = .48, .56, .60, and .80 generally agree with resistivity measurements by Westlake¹ and Fukai², which differ significantly near the high temperature β - α transition from the calorimetric measurements of Asano³. Previously unreported transformations of VH₈₀ were detected at 178K, 344K, and 433K. Changes in the slope of the ρ vs. T plot at the higher temperature transformations of VH₈₀ differed from those observed for the lower compositions. Vanadium deuteride and tritide are also to be studied.

^{*}Supported by the U.S. ERDA through Mound Laboratory.

^{**}Operated by Monsanto Research Corp. for the U.S. ERDA under Contract No. EY-76-C-04-0053.

¹D.G. Westlake, et al., Met. Trans. **1**, 1361 (1970).

²Yuh Fukai and S. Kazama, Scripta Met., **9**, 1073(1975).

³H. Asano, et al., Acta Met., **24**, 95 (1976).

F 5 The Energy Dependence And Flux Dependence of Dislocation Pinning in Electron Irradiated Copper. PAOSHIB CHEN, GAIL JONES BROWN and H.M. SIMPSON, Physics Dept., Wright State University. -- A polycrystalline

copper foil has been electron irradiated at temperatures of 78 K, 330 K, and 573 K with energies between 0.25 MeV and 2 MeV. From the dislocation pinning rate measurement at 330 K, the threshold displacement energy was found to be less than 10.8 eV. In addition, the time dependent dislocation pinning rate was measured for a span of two orders of magnitude in point defect production rates at fixed electron energy (0.50 MeV). From the scaling data taken at 0.50 MeV, and at a temperature of 330 K, the pinning rate was found to be proportional to the value of the electron flux raised to the power of 0.806.

F 6 Amplitude Dependence of Dislocation Damping in High Purity Copper After Quenching and Electron Irradiation. R.J. KERANS and H.M. SIMPSON, Physics Dept., Wright State University. -- Dislocation - point defect interactions in high purity copper were studied by measuring Young's modulus and the logarithmic decrement near room temperature. Vacancies were introduced by quenching from 500°C at an initial quench rate of 2000°C per second. Interstitials and vacancies were created by irradiation with 1 MeV electrons. Of primary interest were strain amplitude dependent effects; in particular, the determination of the existence or non-existence of an initial increase in damping after quenching ("peaking effect").¹ Pursuant to this end, it was necessary to measure the modulus and the damping at strain amplitudes varying over several orders of magnitude.

¹H.M. Simpson, A. Sosin, and D.F. Johnson, Phys. Rev. **B5**, 1393 (1972).

F 7 Positron Annihilation in Copper. K. WHITE,[†] W.H. RICKLES,^{††} and T.W. LISTERMAN, Wright State University. -- An angular correlation apparatus for the detection of the two coincident γ rays emitted during positron-electron annihilation in materials has been constructed. The apparatus was used to examine annihilation in both annealed and unannealed copper samples and the analyzed results were found to agree with published results.

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[†]Submitted in partial fulfillment of the requirements for the degree Master of Science. Present address, Mound Laboratory, Monsanto Research Corp., Miamisburg, Ohio.

^{††}Supported by the NSF Undergraduate Research Participation Program. Present address, Dept. of Physics, Otterbein College, Westerville, Ohio.

F 8 Studies of Polarized Absorption Spectra of Nd³⁺ in Yttrium Orthovanadate at 770K. H.L. PARK, J.M. O'HARE, and P.P. YANEY, Univ. of Dayton--The upper Stark levels corresponding to the $4F_{3/2}$ through the $2I_{11/2}$ states and their irreducible representation labels were determined. The studies covering 340 nm to 892 nm were recorded using a Jarrell-Ash 3.4 m high-resolution spectrograph. The spectra were analyzed using published "free-ion" energy levels and the splittings and irreducible representation labels of the ground state of Nd³⁺:YVO₄ given by Yaney and DeShazer.¹ We established 14 Stark levels and 75 irreducible representation labels in addition to those previous published.² Vacuum wavelengths and the peak absorption coefficients of the observed transitions were also obtained.

¹P.P. Yaney and L.G. DeShazer, J. Opt. Soc. Am. **66**, 1405 (1976).

²A.A. Kaminskii, G.A. Bogomolova, and L. Li, Izv. Akad. Nauk. SSSR, Neorgan. Mater. **5**, 673 (1969).

F 9 An Undergraduate Teaching Project on the Conformation of Macromolecules, II. KHIN