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Temperature-Dependence of Electron Mean Free Paths in Tungsten

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WINDMILLER, Argonne Nat'l. Lab., and J. B. KOTHEIMER, Northwestern University. - Measurements of Dingle temperatures have been performed on three dilute alloys of AuMg. Since Mg alloys into Au with virtually no change in lattice constant, this system should exhibit pure potential scattering, with no impurity-induced strain effects. The measurements were carried out for 17 different orbits in the [110] plane, with Dingle temperatures per atomic percent at [110] being 77.8 ± 3.9K for the neck and 107.4 ± 5.4K for the belly. Results of a phase shift parametrization of the data, with and without the inclusion of relativistic effects, will be reported.

*Work supported by NSF grant #NH-2699, the USAD, and the Northwestern University Materials Research Center, and carried out at both the University of Oregon and Argonne Nat'l. Lab.

CJ 6 The Influence of Defect Scattering on the Low Temperature Transport Properties of Pure Aluminum. — D. J. VANHARLINGEN and J. C. GARLAND, Ohio State U. - It is well established that defect scattering in pure aluminum can dominate the low temperature residual resistivity. We have investigated the effects of defect scattering in aluminum on the temperature dependence of the electrical and thermal resistivities, thermoelectric power, and thermoelectric function G(T/|Q)|. Measurements were made on polycrystalline samples with residual resistance ratios ranging to 30,000 over the temperature range 1.8-7.0K. Deviations from Matthiessen's rule were noted in the predominantly quadratic electrical resistivity. The thermoelectric power showed nearly the same linear temperature dependence for all samples, while the thermoelectric function G(T) exhibited a marked dependence on defect scattering.

*Research supported in part by NSF Grant GH-53385.

CJ 7 Normal and Umklapp Phonon Decay Rates in Potassium at Low Temperatures. - R. C. ALBERS, L. BOHLM, W. ROT, and J. W. WILKINS, Cornell U. — Phonon decay rates in potassium due to phonon-phonon and electron-phonon scattering are calculated and compared for small wave-numbers at low temperatures (-1 to 10 K). The phonon-phonon half-widths Γpp have a strong dependence on the temperature and magnitude of |Q|, but are roughly independent of the direction of Q. The electron-phonon half-widths Γep are temperature independent, linear in |Q| for Q < 6.0 3R/a, and have a strong directional dependence on |Q| for the transverse phonon nodes. At high temperatures (Q > 30 K) Γpp dominates Γep. At lower temperatures the two are comparable to each other and the situation is complex. Along certain directions in Q space for certain branches Γep may dominate whereas along symmetry directions at small Q for the transverse branches Γep is zero and Γpp dominates. The relevance of these and other results are discussed in the context of low temperature transport properties.

CJ 8 Differential Magnetic Susceptibility for Semimetals near the Quantum Limit. — D. E. HENDRICK and D. H. LOWNDES, U. of Oregon. — The wavefunction of the oscillatory differential magnetic susceptibility near the Quantum Limit has been calculated for a free electron dispersion relation and for the Lax non-parabolic dispersion relation. The wavefunction calculations allow one to extract information about the electron and hole scattering rates and phase smearing in the high magnetic field regime ("Quantum Limit") where the usual Lifshitz-Kosevitch formalism of the de Haas-van Alphen effect is no longer valid. Applications to bismuth will be discussed.

*Supported by NSF Grant No. GH-42593.


C. Barklie and D. Shenber, International Conference on Electron Lifetimes in Metals (July 8-19, 1974, Eugene, Oregon; to be published).

CJ 9 Quantitative Results for the Mg Electron Quantum State Interferometer. — R. M. GREENBERGER, U. of Chicago and U. of Arizona, and R. W. SMITH, U. of Arizona. - The results of a series of experiments performed to measure the interference oscillations observed at 4.2 K in the transverse magnetoresistance of pure Mg with J/[110] and H/[1010] will be reported. These new experiments were undertaken to eliminate data acquisition and data analysis approximations in the previous measurements of these quantum interference oscillations.

The specific problems encountered in obtaining quantitatively accurate data will be dealt with in some detail. As will be shown, the excellent agreement obtained in fitting theoretically calculated lineshapes to the experimentally observed magnetoresistance oscillations provides a striking confirmation of the theory and indicates that the interferometer in pure Mg is now well understood. As discussed in Ref. 1, the interference oscillations in pure Mg are characterized by three magnetic breakdown parameters A1, A2, and A3. The experimental values obtained for these parameters in the present study are in much better quantitative agreement with band structure predictions than the experimental values quoted in Ref. 1.

*Supported in part by the Natl. Science Foundation.


CJ 10 dHvA Studies of Conduction Electron Scattering and Impurity State Structure, for Dilute Co Impurities in Au. — YUN CHUNG and D. H. LOWNDES, U. of Oregon. — Measurements of orbitally-averaged conduction electron scattering rates (Dingle temperatures) are reported for scattering by dilute Co impurities in Au, using single crystal samples prepared under different annealing conditions. The Dingle temperatures are temperature-and field-independent over the ranges 35-4.2K and 34-3K for the quantum interference effect of Mg at 4.2 K.

A partial wave analysis of the scattering anisotropy over the Fermi surface shows that s-wave scattering is dominant with strong d-wave scattering in addition, in contrast to recent results for Cu(Fe) and Cu(Ni), for which the scattering can be described as exclusively d-wave. The Friedel sum is calculated from the Dingle temperature data, with the result that the number of electrons displaced in the neighborhood of an impurity is -2.0. Wave shape Analysis for the Neck orbit, using the dHvA second harmonic content, confirms that the scattering is independent of both H and T.

*Supported by NSF Grant No. GH-42593.


CJ 11 Temperature Dependence of Electron Mean Free Paths in Tungsten. — P. D. HAMBOURGER, Cleveland State U. — Temperature dependence of mean free paths has been measured in high-purity tungsten by means of the size-dependent oscillatory magnetoresistance effect. For the non-central orbit on the hole octahedron with extremal 3A/kv, we find t-1/4(2K)-1/2[(0.2)1/2]2 with H/100, where λ is the mean distance an electron travels parallel to H between effective collisions. The data show no evidence of anomalous loss of amplitude at low temperatures observed in rf size effect signals by Thompson and Myers. Data will be dis-
cussed in relation to the unusual temperature depen

dence of the bulk resistivity of tungsten.4

1 Samples were prepared from a crystal kindly lent by
B.K. Wagner.

20. E. Soule and J. C. Abele, Low-Temperature Physics -

3J. S. Thompson and A. Myers, J. Phys. F: Metal
Physics, 3, L64 (1973).


3 Calculation of the Low Temperature Ideal Elec-
trical Resistivity of Copper. J.E. BLACK, M. BRETT,
Brook U. -- We have performed a two - O.P.W. calculation
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The 8-cone model of Ziman was used to approxi-
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