THEORY OF THE G-FACTOR OF TWO-DIMENSIONAL GRAPHITE*

J. W. McClure (University of Oregon, Eugene, Oregon) - A new calculation of the spin resonance g-factor of two-dimensional graphite has been performed. A correction to the previous calculation[1] has been found. The new term comes from the spin-orbit splitting of the Landau level at the band degeneracy (n=0). Though the splitting is independent of the magnetic field, the degeneracy of the Landau level is proportional to the magnetic field strength so that the term produces a field-independent contribution to the average g-factor. The total g-shift may be written:

$$\delta g = \frac{\alpha\lambda x}{\mu \ln(2\cosh x)}\left[\left(\frac{3ma^2\gamma_0^2}{2\hbar^2\mu}\right)\frac{x}{\sinh^2 x} + \alpha \tanh x\right], \qquad (1)$$

where $x = \mu/2kT$, μ is the energy of the Fermi level, k is Boltzmann's constant, T is the absolute temperature, α is the probability coefficient of 3d-functions in the π band,[1] λ is of the order of the 3d atomic spin-orbit interaction,[1] γ_0 is the two-dimensional band parameter, m is the electron mass and $\hbar$ is Planck's constant divided by 2π. The result may also be written in the following way:

$$\delta g \chi_p = \frac{2\hbar^2\alpha\lambda}{\gamma_0^2 ma^2}(\chi_1 - \chi_3) + \alpha^2\lambda\frac{\partial}{\partial\mu}\chi_p, \qquad (2)$$

where χ_p is the calculated paramagnetic susceptibility of the conduction electrons and $\chi_1 - \chi_3$ is the anisotropy in the calculated diamagnetic susceptibility.[2]

A calculation for the two-dimensional model is of interest as it has been established that ideal turbostratic carbon behaves like two-dimensional graphite for motion of electrons parallel to the layer planes. A formula similar to (2) has previously been proposed on the basis of experimental results for pyrocarbons.[3] It is interesting to speculate that a formula similar to (2) may be derived in general. For the formula (2) to hold for three-dimensional graphite, the demensionless combination of constants $2\hbar^2\alpha\lambda/\gamma_0^2 ma^2$ should have the value 0.5×10^{-4} whereas its value using the parameter values previously determined[1] is 0.8×10^{-4}. Comparisons for other cases will be given.

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[1] J. W. McClure and Y. Yafet, Proceedings of the Fifth Conference on Carbon (Pergamon Press, New York, 1962) vol. I, p. 22.

[2] J. W. McClure, Phys. Rev. 104, 666 (1956).

[3] A. Pacault, J. Uebersfeld, J. G. Théobald, and M. Cerutti, Comptes rendus 261, 3589 (1965).