ANORMALOUS HALL EFFECT AND ELECTRONIC STRUCTURE OF PYROLYTIC CARBONS

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(1) Hall voltages of poorly graphitized pyrolytic carbons are found to saturate as a function of the applied magnetic field in high field regions.
(2) This can be attributed to the peculiar energy band structure of these materials, which is essentially of two-dimensional nature.
(3) A novel method to determine such physical parameters as γ_2, acceptor level, and acceptor concentrations is given.

Hall effect experiments are made on pyrolytic carbons at 4.2^{o}k, 20^{o}k, 77^{o}k and 300^{o}k. At low temperatures the Hall coefficients R_H of poorly graphitized samples are found to be inversely proportional to the applied magnetic field. The (R_H vs H) curves at 4.2^{o}k are closely similar to those at 20^{o}k. At 77^{o}k too R_H becomes inversely proportional to the field, but at much higher fields. The anormalous Hall effect is obscured on samples which have graphitized beyond a certain stage.

This peculiar behaviour of the Hall effect is ascribed to the peculiar energy band structure of these materials, which is essentially of two-dimensional nature. Theoretical curves of (R_H vs H) relation, obtained based on the two-dimensional band model, reproduce the experimental curves fairly well. The Hall effect anormally cannot be observed in a single crystal of graphite, in which the band structure is endowed with three-dimensional nature by the interlayer interaction. The larger layer spacing together with the poorer layer order makes the electronic structure of the turbostratic carbons almost ideally two-dimensional, which gives rise to the observed anormally.

Exact theoretical calculations of (R_H vs H) relation based on the three dimensional band model is too difficult. A temporary expedient is devised to circumvent the difficulty. The inclusion of the effect of the slightest interlayer interaction into the calculation improves the fittings of the theoretical with experimental curves very well. Because the shapes of the theoretical curves thus obtained varies drastically if the values of the parameters (γ_2, E_a, N_a) are varied[1], one can determine the values of these by the (R_H vs H) curves obtained experimentally.

Reference

(1) Kazuhiko YAZAWA, Report of the University of Electro-Communications No. 21, pp.33-46, Dec. 1966