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(ABSTRACT)

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NEW ASPECTS OF CONDUCTION ESR AND ELECTROCONDUCTIVITY IN GRAPHITE AND ITS ACCEPTOR INTERCALATION COMPOUNDS

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In this report the results of experimental and theoretical investigations of previously unknown aspects of the conduction ESR (CESR) phenomenon and electroconductivity in graphite and acceptor graphite intercalation compounds (GICs) are presented.

We have studied influence of sample size, microwave electromagnetic field configuration, constant magnetic field orientation and modulation frequency, temperature and stage index on the lineshape and intensity of the graphite and GICs CESR signal. The theoretical calculations of the CESR lineshape in graphite and GICs were carried out in the framework of the 2D modification of the Dyson-Kaplan theory and within this model the qualitative explanation of basic peculiarities of the experimental data were obtained. As for graphite and GICs with nitric acid synthesized in strong concentrated acid, to achieve a qualitative agreement it is necessary, in addition, to take into consideration the presence of surface spin - relaxation mechanism or/and (for graphite) the dependence of the ratio of a mean value of the microwave amplitude at the non equivalent sample faces on a sample size. Basing on these conceptions, we proposed the new procedure to determine from CESR signal lineshape and intensity analysis: the basal plane (σ_a) and c-axis (σ_c) electroconductivity, the spin carrier diffusion constant and the density of states at the Fermi surface. We believe that the origin of the similar temperature dependencies of the basal plane electroconductivity and CESR linewidth is due to the fact, that the spin-orbit interactions in the vicinity of intercalate domain walls or/and intercalate island boundaries are the main CESR relaxation mechanisms in acceptor GICs and their contributions increase with the in -plane conductivity increase. In some GICs, such as in GICs with nitric acid synthesized in strongly concentrated acid for the interpretation of the CESR data, it is necessary to take into consideration the presence of the small concentration of the localized spins, in addition to the surface relaxation effects. In the latter case the contribution of the surface relaxation effects and concentration of the localized spins undergo the step-wise changes at the aggregate phase transition in the intercalate subsystem.

CESR - techniques was used for the determination σ_c - electroconductivity of GICs through the value of asymmetry parameter A/B of their resonance signal. As a result, earlier unknown peculiarities of electroconductivity in low stage GICs with structural incommensurate phase are found. In such GICs the temperature dependence of (σ_c) in their incommensurate phase is absent, in spite of the presence of the temperature dependence of σ_a The analysis of experimental results shows that this phenomenon it is impossible to explain in terms of band model of σ_c - electroconductivity. It may be explained in the framework of non-band model of conduction path (channel) mechanism of σ_c - electroconductivity by assuming that in phase under consideration the relaxation rate of carriers in the graphite basal plane due to impurity and structural imperfections in intercalate layers is much creator than that due to the phonon scatting and, in addition, that the concentration of defects (α conduction path) in this phase varies with temperature. Invariability (or even small reduction) of σ_c-conductivity at α□β-transitions in GICs with nitric acid confirms the conclusion on non-band nature of the σ_c-electroconductivity. From this investigations also follows that in some phases of GICs the σ_a "metallic" temperature dependence can be caused by the in-plane intercalate ordering.

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