ANOMALOUS HALL EFFECT IN GRAPHITE INTERCALATION COMPOUNDS WITH COBALT

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The aim: to establish the features of magnetic and magnetotransport properties of graphite intercalation compounds with cobalt

Host graphite	Intercalation method
• HOPG: (High Oriented Pyrolytic graphite) • d_{002} = 0.335 nm • the crystallite size L_b = 500 nm • the parameter of preferred crystallite orientation η = 10^5	• two-stage intercalation method with use C8K as precursor: 1-st stage: the GIC C8K was obtained by standard gas-phase method. 2-st stage: cobalt chloride in the interlayer space of graphite was reduced to cobalt by the scheme: C8K + MClx → C-Me + KCl. Reaction was carried out in the medium of THF.

GIC: S = 2, I_s = 0.975 nm, size of GIC clusters is ~ 10 nm

Obtained GIC

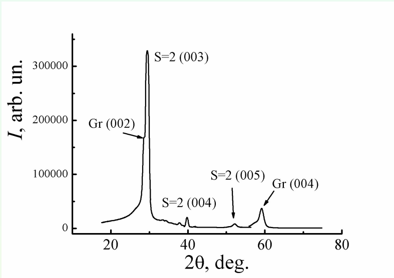


Figure Fragment of X-ray diffraction pattern for GIC with cobalt

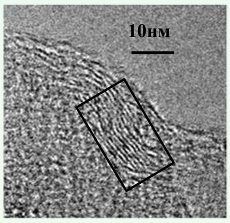


Figure 2. The fragment of TEM-imagine of GIC with cobalt

Magnetic properties:

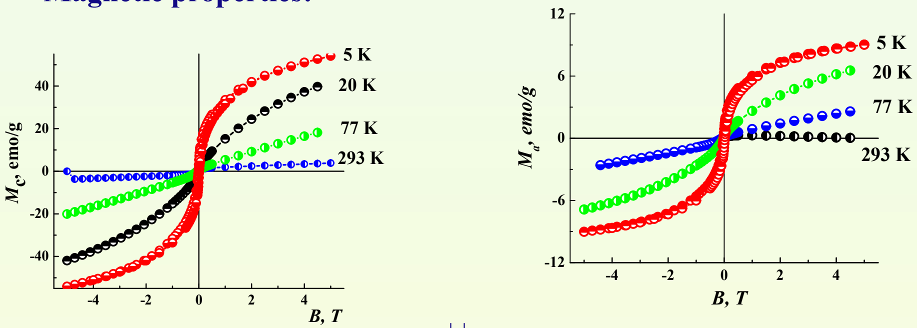


Fig.3. Dependences $M(B)$ for GIC with Co, M | | B (a), M ⊥ B (b)

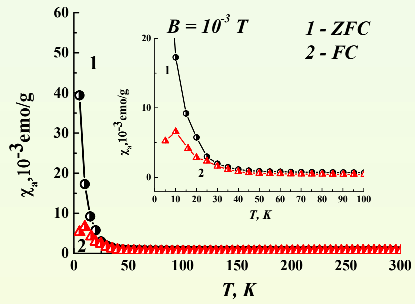
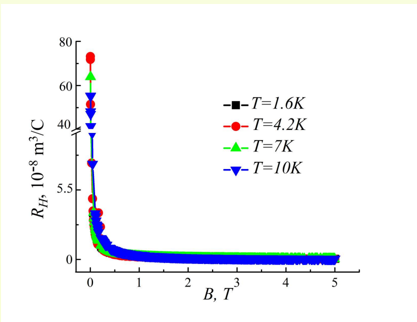


Fig.4. Dependence χ_a(T) for GIC with Co

Magneto-transport properties:

Anomalous Hall effect



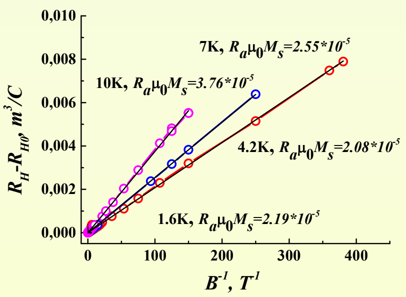


Fig. 5. Field dependence of the Hall coefficient $R_H(B)$ (a) and dependence $R_A\mu_0M_s$ on 1/B for GIC with Co

$$R_H = R_{H0} + R_A\mu_0M_s/B$$

The abnormal Hall effect is caused by spin-orbit interaction, which leads to the formation of asymmetry in the scattering of conduction electrons and Hall deflection in the absence of an external magnetic field. The anomalous Hall coefficient for magnetic granular systems exhibits non-monotonic changes with changing magnetic field due to its influence on the nature of charge carrier scattering. In addition, the dependence of R_A on magnetic field is due to the size of the granules.

Asymmetric Magnetoresistance

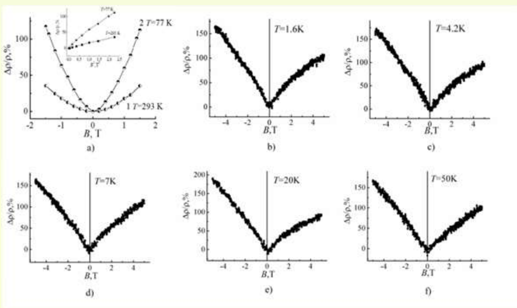


Fig. 6. Dependences $\Delta\rho/\rho(B)$ for source for intercalation HOPG (a) and for GICs-Co at temperatures 1.6 K (b), 4.2 K (C), 7 K (d), 20 K (e), 50 K (f)

$$\rho(B) = \rho_e(B) + \alpha B$$

Asymmetric magnetoresistance occurs in systems for which:

1. Heterogeneous or cluster structure. GIC HOPG-Co is a graphite matrix with clusters of intercalated graphite.
2. Magnetization heterogeneity. GIC is a layered structure characterized by ferromagnetic properties with a high level of magnetic anisotropy.
3. Anomalous Hall effect.

Conclusions

An anomalous Hall effect was found in graphite intercalation compounds based on HOPG with cobalt, which arises from the significant spin-orbit interaction between charge carriers in the graphite layers and the magnetic moments of the cobalt atoms during the formation of magnetic GICs clusters within the graphite matrix.