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Polaronic transport and magnetic field dependence of conduction parameters in rGO-CFO nanocomposites

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In this work we report the AC conductivity σ and magnetoconductivity Δσ of a series of reduced graphene oxide-cobalt ferrite (rGO-CFO) composites in which the mass ratio of rGO:CFO has been systematically varied over six compositions. The conductivity measured in the frequency range of 20 Hz to 3 MHz showed an anomalous increase with CFO content in the composite, even though the conductivity of CFO is at least three orders of magnitude smaller than that of rGO. Magnetoconductivity measured in fields upto 2000 Oe displayed both negative and positive values depending on the rGO:CFO ratio. Maximum magnetoconductivity of ~ +14% was obtained at room temperature in a magnetic field of only 750 Oe. Samples having the largest σ and Δσ values also showed significant softening/hardening of the Raman active modes of CFO, indicating polaronic transport in these composites. Fits of σ(f) data to a power law $\sigma(f) = \sigma_o + Af^n$ showed that parameters A and n depend strongly on the applied magnetic field. This dependence is qualitatively and quantitatively different for samples that display positive or negative magnetoconductivity. Although the temperature dependence of these conduction parameters has been extensively studied, we have not come across any reports of their magnetic field dependence. Based on these observations we present a surface polaron model in which hybridization of π-orbitals of graphene with surface states of CFO nanoparticles provides for a polaron conduction mechanism through a grid of CFO nanoparticles intercalated with rGO sheets.

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References

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