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Magnetoresistance Transition from Negative to Positive in Functionalization of Carbon Nanotube and Composite with Polyaniline

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Abstract : Carbon nanotube (CNT) is a well-known material for very good electrical, thermal conductivity and high tensile strength. Because of that, it's widely used in many fields like nanotechnology, electronics, optics, etc. In last two decades, polyaniline (PANI) with CNT and functionalized CNT (fCNT) have been promising materials in application of gas sensing, electromagnetic shielding, electrode of capacitor etc. So, the study of electrical conductivity of PANI/CNT and PANI/fCNT is important to understand the charge transport and interaction between PANI and CNT in the composite. It is observed that a transition in magnetoresistance (MR) with lowering temperature, increasing magnetic field and decreasing CNT percentage in CNT/PANI composite. Functionalization of CNT prevent the nanotube aggregation, improves interfacial interaction, dispersion and stabilized in polymer matrix. However, it shortens the length, breaks C-C sp^2 bonds and enhances the disorder creating defects on the side walls. We have studied electrical resistivity and MR in PANI with CNT and fCNT composites for different weight percentages down to the temperature 4.2K and up to magnetic field 5T. Resistivity increases significantly in composite at low temperature due to functionalization of CNT compared to only CNT. Interestingly a transition from negative to positive magnetoresistance has been observed when the filler is changed from pure CNT to functionalized CNT after a certain percentage (10wt%) as the effect of more disorder in fCNT/PANI composite. The transition of MR has been explained on the basis of polaron-bipolaron model. The long-range Coulomb interaction between two polarons screened by disorder in the composite of fCNT/PANI, increases the effective on-site Coulomb repulsion energy to form bipolaron which leads to change the sign of MR from negative to positive.

Keywords : coulomb interaction, magnetoresistance transition, polyaniline composite, polaron-bipolaron
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