SPIN AND CHARGE LOCALIZATION AS THE CONTROLLING FACTOR OF THE ELECTRICAL TRANSPORT IN ACTIVATED CARBON FIBERS

Damian Markowski

Localization effects play the crucial role in the charge carrier transport in different materials. This phenomenon has been investigated and described in many scientific works. The most commonly used definition of this phenomenon is based on the particle wave-function – for a given particle this function decays exponentially outside of the localization region. This description is applicable not only to the materials with granular structure but also to the systems with randomly spaced impurities and structural defects which can act as the localization centers. Such defects generate non periodic potentials which create percolation paths for charge carriers. It is also important for non-continuous granular carbon nanostructures, where the conducting nanoparticles are separated by some dielectric medium which forms the potential barriers between the localization regions (the nanoparticles). By using specific medium it is possible to modify these barriers by changing the host-guest interaction . This approach is the most appropriate for the problem connected with the presence of spins and charges in various nano-carbons which are analyzed in the thesis. Activated carbon fibers – ACF, are in the group of porous materials with specific properties important from the point of view of the possibility to control the electrical transport. The dielectric guest molecules and controlled porosity of ACF are the most important factors which give the possibility of controlling the electrical transport within the fibers. In these systems the charge carrier transport occurs through the two possible mechanisms – tunneling and hopping. For the interacting charges it is necessary to take into account the additional energy connected with the Coulomb repulsion, what can lead to the formation of the Coulomb blockade.

Systematic investigations of the localization effects in the set of several ACF systems were performed using two basic methods – the four contact electrical conductivity measurements and the electron paramagnetic resonance (EPR) spectra. Additional method – Raman spectroscopy, was used to confirm the results obtained by the two abovementioned methods. Supporting experimental techniques: the transmission electron microscopy (TEM) and analysis of the adsorption isotherms recorded via N_2 adsorption at 77 K helped to characterize the porosity of ACFs.

All the above concepts are commonly used to describe the quantum dots and other single-electron systems, which seem very important for the future applications in molecular electronics and spintronics.