
**ACTIVATED CARBON FIBER AS A GRAPHENE
BASED QUANTUM DOTS SYSTEM**

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Activated Carbon Fiber (ACF) is a porous material composed of nanographitic units (NGU) connected in specific way - with the short carbon chains or graphene fragments. Single NGU is formed of the stack of 3-6 small graphene sheets to create a turbostratic texture. Such a system exhibits peculiar electrical transport which is defined by the effects characteristic of quantum wells controlled by the level of localization of carriers within NGU. Adsorption of various molecules in ACFs porous system significantly influences the electronic and structural properties of the NGU system which can be treated as a quantum dots matrix.

The basic aim of this work is to determine the experimentally established conditions for designing quantum dots matrices as a qubit-systems with controlled population of spins localized in quantum wells (dots) separated by adjustable potential barriers.

In our model localization of spins within NGU is described with the fusion of two approaches: Curie-law behavior studied with electron paramagnetic resonance (EPR) and granular metal-like transport [1]. Strong changes in the spin localization detected by EPR are observed when potential barriers for hopping of charge carriers between NGUs is modified by guest molecules. The strongest changes are observed in case of the host-guest interaction if guest molecules are dipolar [1-3]. This model correlates well with the Coulomb-gap variable-range hopping approach (CGVRH), characteristic of charge transport in granular systems [4]. CGVRH model defines an important parameter T_0 with the equation $\rho = \rho_0 \exp(T_0/T)^{1/2}$, where ρ_0 is a proportionality constant, ρ is the resistivity and T temperature. T_0 can be treated as an activation energy needed for electrons hopping between NGUs. Modifications of the potential barriers between NGU by introduction of specific molecules inside the ACF pores is observed as a change of T_0 , which strongly depends on the dipole moment of the substance adsorbed in pores. This effect is clear when plotting resistance R as $\ln R$ versus $T^{-1/2}$ for the following substances: H_2O , D_2O and $C_6H_5NO_2$ - see Figure 1. Slopes of obtained straight lines define the T_0 . Results could be discussed in a frame of ballistic transport phenomenon characteristic of grapheme-based connections between NGU in the ACF's porous structure.

Another way to influence the spin localization and transport properties of matrices of NGU can be the external electric field. Figure 2 shows the first result of the influence of the electric field on the spin localization in ACF and the transport of carriers.

Carbon nanomaterials with controlled localized spin population and carriers transport should become important from the point of view of possible future spintronic applications [5].

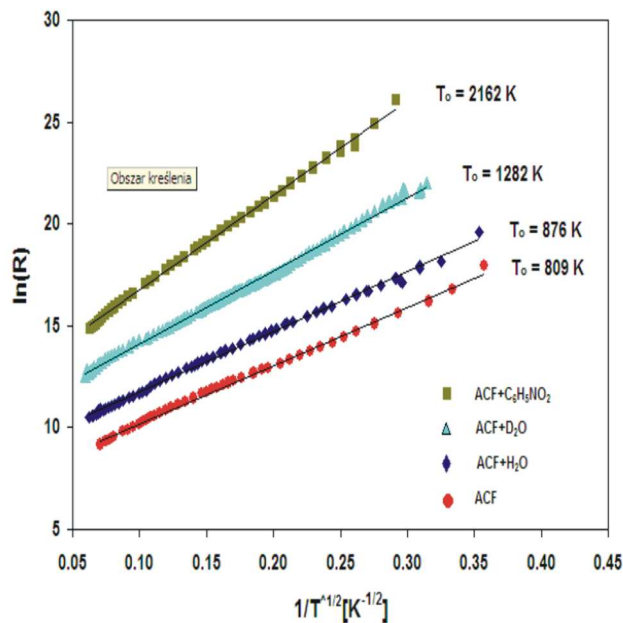


Figure 1: The dependencies of $\ln R$ versus $T^{-1/2}$ of pure ACF and ACF filled with different dipolar molecules. The activation energy T_0 increases with increasing dipole moment of the adsorbed molecules. Dipole moments of H_2O , D_2O and $C_6H_5NO_2$ are as follows: 1.85 D, 1.87 D and 3.98 D respectively.

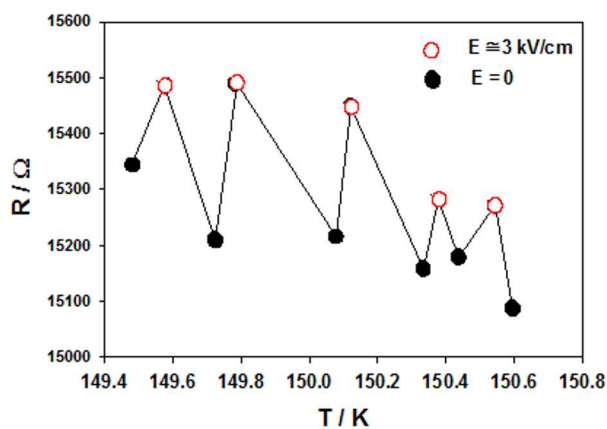


Figure 2: Temperature dependence of the resistance of ACF filled with H_2O molecules. There is a clear correlation of resistance changes with switching on/off the external electric field.

References

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