Magneto-transport in dense arrays of multiwall carbon nanotubes

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We introduce a method of assembly of functionalized multiwall carbon nanotubes (MWCNT) into monolayers (dense arrays). In contrast to the standard morphologies of the samples of arrays of nanotubes involving definitions of bundles (ropes), mats, networks, etc., based on hardly controlled deposition from organic solvent dispersions of pristine nanotubes, we use "simulation" of the Langmuir-Blodgett (LB) technique. The method we propose offers a radical departure from the existing methodology due to the possibility to cover large surfaces with dense thin films of carbon nanotubes.

To our knowledge, up to now, there is no experimental data on electrical and magneto-transport properties characterization of dense layers manufactured using LB assembling of functionalized nanotubes. The obtained layers (dense arrays) of MWCNTs are expected to be used for new applications in chemical and biosensors, controlled by the electrical transport. We also have tested the samples of MWCNT, deposited on the substrates from a suspension in organic solvents for comparison. Due to the low concentration of the MWNT in the solution, the coverage of the electrodes was found to be "island"–like.

The nanotubes samples on the electrodes with "finger-shape" geometry have shown low resistance(<1kΩ. at room temperature) and a "weak" power law dependence of the resistance on temperature in the range T=4.2 –300 K. It is interesting to point out that for both samples, non-functionalized and functionalized MWCNTs, the temperature dependences of the resistance are similar and represent a power-law in the temperature range lower than ~100K with the exponents –0.38 and –0.22, respectively. While such a power law can fit the temperature dependence of the resistance in MWCNT, it is suggested the formation of a Luttinger liquid.

In both types of the samples of non-functionalized and functionalized MWCNT's a negative magnetoresistance, characteristic of the weak localization state was observed. In addition to the high field negative magnetoresistance for the functionalized nanotubes we observed a positve magnetoresistance at low fields as a signature of weak antilocalization. We also observed oscillations of magnetoresistance, which appear to be periodic in 1/B, and could be considered in terms of Shubnikov de Haas oscillations. To our knowledge, the Shubnikov de Haas – like oscillations in carbon nanotube samples in high magnetic fields were observed for the first time.