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Матеріали
X міжнародної наукової конференції

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Dedicated to the memory of Oleh Parasyuk and Iwan Kityk

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SINGLE/MULTI-WALLED NANOTUBES COMPOSITES STUDIED AT LOW TEMPERATURES

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Carbon nanotubes are essentially cylindrically-shaped molecules built up from a single layer of carbon atoms, known as graphene. Speaking of polymer-based nanocomposites, increased attention is recently paid to poly(3,4-ethylenedioxythiophene) - PEDOT host matrices doped by poly(styrene sulfonate) (PSS) [1] and reinforced with carbon nanotubes.

The aim of this work is study the electrical properties of single- and multilayer carbon nanotubes composites at low temperatures on the range from 50 to 200 K.

Nanocomposites were fabricated starting with water suspension (1%) of poly-3,4,-ethyldioxythiophene utilizing a surface-active anionic substance as a stabilizer. So, single carbon nanotubes (SWCNTs) with 90 wt.% and average radius less than 1 nm and multilayered carbon nanotubes (MWNTs) with 95 wt%, mean outside diameter of 65 nm and mean inside diameter near 10 nm were obtained. By varying the ratio between PEDOT:PSS solution and suspension of nanotubes, films with different concentration of nanotubes (12 wt% and 16 wt%) were fabricated [2].

For measurements of lateral resistivity E7-20 RLC instrument was exploited. It provides the capability of detecting complex impedance from 10^{-5} Ohms up to 1 GOhm with excitation signal ranging from 40 mV to 1 V. The frequency range covered by this instrument is 25 Hz to 1 MHz. Measurements of temperature dependencies were performed in cooling and heating regimes with custom-made cryoequipment and DE-202A closed cycle cryocooler. For controlling functions, Cryocon 32 temperature regulator was used.

The concentration of nanofiller appears to have little impact on the activation energy as the straight lines in the temperature range form 90 to 300 K are almost parallel for all studied nanocomposites.

As far as charge transfer between individual nanotubes is considered, one has to take into account the tunneling mechanism of charge transfer. This mechanism is related to fact that there are energy barriers between adjacent nanotubes and certain probability exists that electrons may overcome such barriers if the distance between tubes is small enough.

Lateral electrical resistance of specimens of PEDOT:PSS polymer with addition of certain amount of single- and multi-walled carbon nanotubes were investigated in the range of temperatures from 50 to 200 K. Arrhenius equations were used to fit the collected data to the model of activation conductivity model.

Respective parameters of the model, such as activation energy were extracted and compared for samples doped with single-walled only carbon nanotubes and multi-walled only carbon nanotubes. The latter nanocomposites show lower resistance at the same temperatures.

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