Low temperature AC electrical study of single/multi-walled carbon nanotubes-based composites

***Karbovnyk I.*[1], *Lukashevych D.*[2], *Chalyy D.*[2], *Olenych I.*[1], *Klym H.*[3]**

[1] *Department of Electronics and Computer Technologies, Ivan Franko National University of Lviv, 107, Tarnavskogo Str., Lviv, 79000, Ukraine*
E-mail: ivan_karbovnyk@yahoo.com
[2] *Lviv State University of Life Safety, 35, Kleparivska Str., Lviv, 79000, Ukraine*
[3] *Department of Specialized Computer Systems, Lviv Polytechnic National University, 12, Bandera Str., Lviv, 79013, Ukraine*

In this work systematic study of electrical properties of single- and multi-walled carbon nanotubes composites on the temperature range of 50-200 K were performed. Hybrid composite films were prepared starting from 1% water suspension of poly-3,4,-ethyldioxitiophen. Two types of nanofiller were used: purified (90 wt%) single-walled carbon nanotubes with average diameter of 1 nm and purified multiwalled carbon nanotubes (95 wt%) with average outside diameter of 65 nm, average inside diameter of 10 nm.

Prepared samples were subjected to low-temperature impedance measurements. Temperature dependencies of the measured sheet resistance of the single- and multi-walled carbon nanotubes composite films were measured at 100 kHz frequency in the range of 50 to 200 K. Reasons for selecting such temperature range limits were relatively small variation of resistance from 200 K up room temperature (total resistance at higher temperatures is determined by random network of nanotubes with tunneling barriers between individual tubes) and rapid increase of resistance for single-walled carbon nanotubes composites below 50 K, so that the values of R were beyond the range of measurements for RLC meter.

Generally, lateral resistance of composite films increase non-linearly upon cooling. The dependencies are split in two sub-ranges, since, as shown below, there are possibly different mechanisms involved below and above 90 K. As far as different loadings of nanofiller are considered, sheet resistances decrease with nanotube concentration.