Carbon Nanotubes separation techniques – efficiency and selectivity.

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Carbon nanotubes are one of the greatest carbon nanostructures discovered during research on the new materials. Their unique properties arise from one dimensional cylindrical structure, in which diameter is about one nanometer and length exceeds few micrometers. Such a structure exhibits new very desirable electric properties like ballistic electron transport, superconductivity, semiconductivity with narrow band gap and metallic conductivity. Together with these electric properties great mechanical properties like outstanding tensile strength and self-healing in some conditions occur. Beside the electric and mechanical properties, nanotubes demonstrate high thermal conductivity along the axis. Combination of these electric, mechanical and thermal properties gives promising opportunity for new electronic compound production. However, synthesis methods are not sufficient for applications in electronics. As-produced material (raw SWNCTs) is a mixture of different species without specified electric properties. In order to use SWNCTs as a new electronic component, one should separate the semiconducting nanotubes from metallic ones.

In this contribution we present the effects of different approaches in the single-walled carbon naotubes separation field. We show the results of dispersion/decantation method, selective destruction of one type of nanotubes and gel permeation chromatography technique. By verifying advantages and disadvantages of proposed method we point out at the most promising for future application.

Comparing all separation techniques one can clearly see that some are more efficient but other more selective. Finding the optimal method is very important from economic point of view. Dispersion/decantation method is very energy consuming since it requires ultrasound application in order to disperse nanotubes. Additionally this method use toxic organic solvents which need to be recovered.

Selective destruction is the simplest and cheapest method, it can be done via oxidation in air. This method can be carried out in flow reactor on a large scale. However, disadvantage of this process is that it is introduces structural defects. Produced material requires additional treatment since it contains amorphous carbon impurities.

The most promising SWCNTs separation method is the gel permeation chromatography. This technique is based on interaction between agarose gel and different surfactants. Chromatography process uses nanotubes water dispersion with surfactant assistance. Preparation of stable suspension is energy consuming, however in this different species of the nanotubes in one process could be obtained.

In conclusion, different methods of nanotubes separation were developed and they can be utilized in larger scale. Selective destruction can be promising method for semiconducting nanotubes production. Selective dispersion/decantation can lead to the precise separation according to chiral index. Low cost chromatographic process is the most efficient way to achieve the metallic/semiconducting nanotubes in a large scale.