Main Features of Experimental Techniques for Carbon Nanomaterials Characterization

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Quasi-molecular solids, such as carbon nanotubes (CNTs) and graphenes, have been widely studied during last years. Due to a unique set of physicochemical and mechanical characteristics, they are promising objects for practical use, in particular, for the production of diverse composite materials. The synthesis of multi-walled CNTs is technologically most simple, and, depending on the synthesis conditions, they can represent a system of either concentrated embedded cylinder (cy-CNTs) or cones (co-CNTs) from graphene sheets. The surface of cy-CNTs consists of sp^2-hybridazed carbon atoms which makes it fairly inert, whereas the near-surface layer of co-CNTs contain both sp^2- and sp^3-hybridized atoms, making them more active in chemical interactions. Graphenes, depends on the size, can have comparable amount of both types of carbon atoms.

Development of new effective selective adsorbents for organic compounds and different ions, materials for physiologically active substances delivery, filled polymers, new catalysts, *etc*. are impossible without preliminary functionalization of CNTs by carboxyl or hydroxyl groups, which, also, open ways to their subsequent modification with more advanced fragments. In generally, there is no analytical technique, providing all the information about CNMs. Only few analytical techniques are suitable for mass qualitative analysis of chemically modified CNTs – thermal analysis with IR and mass spectral control of outgoing gases, elemental CHNSO analysis and X-ray photoelectron spectroscopy (XPS). Among these techniques CHNSO and thermal analysis allow to determine the general contents of oxygen in the material, while XPS can be used only to distinguish surface groups. There also some indirect, but effective, techniques for make similar estimations, such as bomb calorimetry. Present lecture is focused on correlations of the experimental results obtained by different analytical methods of structures carbon nanomaterials analysis and search for the unified set of techniques for their characterization during mass production.