PHYSICO-CHEMICAL PROPERTIES EVOLUTION AND INTERNAL CHANNELS OPENING OF SINGLE-WALLED CARBON NANOTUBES UNDER ELECTROCHEMICAL TREATMENT

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Investigation of single-walled carbon nanotube (SWCNT) internal cavities opening constitute the great fundamental and applied interest [1]. Extremely high attention to SWCNTs in the scientific community caused, first of all, by the promising applications of SWCNTs as the basis for production of transistors [2], sensors [3] and transparent conductors [4], and as promising material for utilization in supercapacitors [5], alkali-ion batteries [6] and electrocatalityc applications [7]. The capability to use SWCNTs as a material in the majority of such applications is highly dependent on the specific surface area of SWCNT films and then on the accessibility of the internal SWCNT voids. Opening of SWCNT internal voids can be accomplished using electrochemical treatment, initially reported by Holloway *et al.* [8]. However, method described in that work has several drawbacks as ambiguity of cavities opening proof and necessity of preliminary SWCNT filling with inorganic compounds that could significantly affect electrochemical behavior of SWCNTs. Some authors report utilization of filling opened SWCNT cavities with β-carotene for establishment of opening phenomenon [9]. Although this approach supports the successful opening only indirectly and requires sophisticated processes of material preparation for the investigation. Therefore, the line under the investigation of SWCNT voids opening and direct proof is still required.

In this work, we have examined physico-chemical properties evolution and their relation to the internal channels opening of single-walled carbon nanotubes under electrochemical treatment. The investigated material was placed on the polyimide substrate with the opening SWCNT film of 90% transmittance in the middle of visible region (550 nm) comprising chaotically oriented SWCNTs synthesized using floating catalyst (aerosol) chemical vapor deposition (CVD) method [10]. The electrochemical treatment itself consisted in the potential cycling of SWCNT film immersed into the 0.5 mol l^{-1} sulfuric acid electrolyte for 100 cycles at 20 mV s^{-1} sweep rate between the bottom limit potential 0.2 V *vs.* RHE and top limit potential 0.7-1.5 V vs. RHE.

The results of the research revealed optical, electrical properties behavior as well as functional composition and structural changes, which were attributed to the I-V curves. It was established that electrochemical opening of SWCNT internal voids opening starts with the top limit potential 0.9 V *vs.* RHE. SWCNT films treated at the top-limit potentials not exceeding 1.1 V *vs.* RHE exhibit the most filling ability. It was claimed that UV-vis-NIR and X-ray photoelectron spectroscopy are more suitable for SWCNT channels opening survey and confirmation.

The authors acknowledge Russian Foundation of Basic Research project no. 20-03-00804. The work was supported by the Council on grants (number НШ-1330.2022.1.3).

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