COMPARATIVE ANALYSIS OF SPECTRA OF THE DIFFERENT SINGLE-WALL CARBON NANOTUBES SAMPLES PRODUCED BY ARC DISCHARGE METHOD

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Abstract: A comparative spectroscopic analysis of SWNT samples with different diameter distribution by using Raman scattering with two different excitation 633 and 1064 nm lines and UV-Vis-NIR spectroscopy is presented.

Single-wall carbon nanotubes (SWNT) are an important class of material for the development of novel electronic and optical devices. Recent advances in the spectral assignments [1-4] can give researchers new tools to understanding of mechanism of SWNT synthesis. We studied Raman and absorption spectra of samples with different diameter distribution of single-wall carbon nanotubes (SWNTs), produced by arc discharge with Ni, Co, Ni/Y and Ni/Gd catalysts, which were purified by successive centrifuging [5]. On the last stage 200000 g. Spectra of these samples are shown on Fig. 1. Purity of samples produced by Co, Ni/Y and Ni/Gd catalysts was 95-98%, and by Ni catalysts it was 30% due to low abundance in a raw soot (< 0,1%). All UV-Vis-NIR absorbance spectra of aqueous (D2O) surfactant dispersions of solitary SWNTs (Fig.1a) are normalized to equal absorbance at 941 nm (in particular spectrum 4 multiplied by 2,3). The normalization results in spectra overlapping at 1658 nm. It means that absorption at 941 and 1658 nm caused by the same nanotubes. It was found that all spectra of solitary SWNTs have the similar shape, which are produced by almost the same diameter set of SWNTs, but they have different distribution. Comparison of Raman spectra of solitary SWNTs solution and solid samples shows that RBM peaks have the same position, but different relative intensity. Shifting of absorption bands occurs due to agglomeration leads to changing of Raman resonance conditions, and that explains these intensity changes. Values of absorption peaks and Raman shifts of RBM modes for Ni/Y, Co and Ni/Gd catalyst samples differ strongly from those predicted by R. Weisman and S. Bachilo (Appl. Phys. A 78, 1111(2004). Comparison of the absorption spectra of different samples shows correlations between the peaks, which belong to v2->c2 and v1->c1 transitions of the same semiconducting nanotubes. The similar overlapping takes place at 646 nm, and that is surprising because the absorption at 646 nm is caused by metallic nanotubes, and at 941 nm by semiconducting ones. 5 semiconducting nanotubes and 5 metallic ones are clearly seen (814, 873, 941, 1010, 1064 nm and 553, 601, 646, 693, 730 nm). The correspondence of absorbencies at 941 and 1658 means that it is caused by nanotube (11,9) in accordance with [3]. As absorption at 646 nm corresponds with Raman shift at 195 cm−1, it is caused by nanotube (9,9) [2]. Therefore, the beginning of growth of (9,9) and (11,9) nanotubes is somehow connected.

The first and second-order, the Stokes and anti-Stokes resonant NIR FT-Raman spectra of these SWNT samples (solid and mixed with KBr powder) and nanotubes dispersed in D2O /surfactant solution and their relationship with a fluorescence background in 1200 -1800 nm region are presented and discussed.
Fig. 1. Absorption spectra of nanotubes produced by Ni/Y (1), Co (2), Ni/Gd (3), and Ni (4) catalysts (1a), and Raman spectra at 633 nm (1b) and 1064 nm (1c) excitation lines.

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