

STUDY OF CARBON NANOSTRUCTURE INTERACTIONS AND INTERFACES WITH BIOLOGICAL MOLECULES

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Introduction

Recent years have excited a significant interest to biological application of carbon nanotubes. The unique electrical and mechanical properties of single-wall (SWNT) and multi-wall (CNT) carbon nanotubes in combination with biological molecules could lead to creation of novel miniature electronic and optical devices, sensors, etc. The mechanism of these effects is still not clear both for simple molecules (water, monomers) and complex molecules such as DNA and proteins.

The presented data include a study of conformational states of DNA and proteins adsorbed on SWNT and CNT.

Methods and materials

The single-wall carbon nanotubes were synthesized by arc discharge between two graphite electrodes in He atmosphere in the Natural Science Centre of General Physics Institute (RAS, Moscow). The length of SWCNT was 1-2 μm and diameter was 1.3-1.5 nm (Fig.1).

Other carbon nanostructures were synthesized in Institute of Surface Chemistry (NASU, Kyiv).

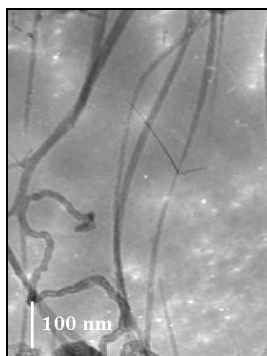


Figure 1. TEM image of single-wall carbon nanotubes.

FTIR and Raman spectroscopy, spectroscopy of plasmon resonance, electron and atomic force microscopy were used. SEIRA (surface enhanced infrared absorption) spectroscopy method that allows to get an enhancement in IR absorption spectra of molecules on rough metal surface up to 10 times [1,2] was used for registration of conformational structure of biomolecules. The spectra were registered in RAS (reflection-

absorption) mode with IFS-48 Bruker instrument.

Results and discussion

Interaction of SWNT with α -helix protein (bovine serum albumin) and β -sheet protein (ribonuclease) was studied.

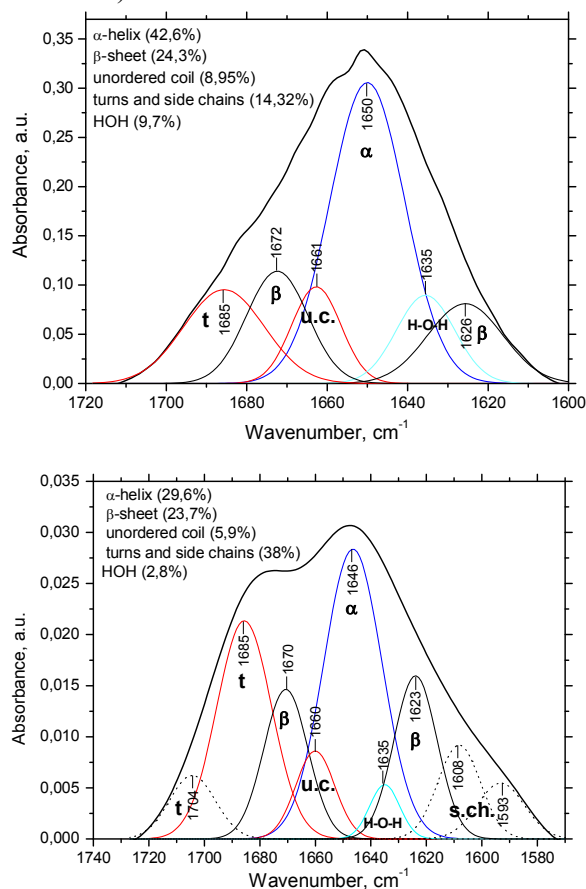


Figure 2. SEIRA spectra of bovine serum albumin in Amid I region before and after interaction with SWNT (the upper and lower spectra, respectively).

Under interaction with SWNT the increase of turns and side chains and decrease of α -helix as well as changes in orientation of protein molecule were registered (Fig.2). The total amount of water decreased from 9,7% in protein to 2% in SWNT-protein complex. Such changes could be caused by noncovalent interactions between proteins and SWNT. We did not observe mentioned effects after interaction with soot.

Study of interaction of SWNT with DNA

showed formation of a stable DNA-carbon nanotube complex [2]. The wrapping of DNA molecules around carbon nanotubes probably occurs under this interaction. SsDNA wraps around SWNT changing its initial conformation to unknown conformation with fragments of A, B, Z forms. In contrast to this dsDNA as usual does not wrap around SWNT, however, it could interact with nanotubes' defects.

Van-der-Waals bonds and π -stacking are determinative binding type in interaction of both proteins and DNA with carbon nanotubes.

New properties of CNT with biological molecules are discussed.

Conclusions

SEIRA spectroscopy method can be used for registration of secondary structure changes in

biological molecules including proteins and nucleic acids.

Study of SWNT and DNA interaction could be used not only for development of new devices but for characterization and identification of nanotubes.

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References

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