Comparison of Carbon Nanoparticles based on their Effect on Erythrocyte Membrane Proteins

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The effect of carbon nanoparticles: nanodiamond (ND), shungite (Sh), fullerenes (F) of 0.01 mg/ml concentration in erythrocyte membrane (EM) suspension over the structural state of the cell membrane protein component including the spectrin cytoskeleton has been studied using ESR spin labeling, spin probing and DSC techniques within the range of 0-80ºC.

Stable carbon nanoparticles (CN) water dispersions were prepared under sonication. ShC nanoparticles were composed of curved graphene stacks <1 nm with dipole moment 6.5D. Dipole of graphene entities interacting with water molecules could play an important role in stabilization of nanocarbon dispersions.

Spectrin cytoskeleton proteins were modified by 4-maleimido-TEMPO spin label. The state of membrane proteins phospholipid microenvironment was studied using 5-DOXYL stearic acid spin probe. ESR spectra were obtained using a EMX Bruker 6/1 ESR spectrometer. DSC measurements were performed using DASM-4 instrument.

In presence of ND and ShC, the proteins inter- and intramolecular mobility is reduced at temperatures above 42ºC as compared to the control suspension of EM. The effect of F is not well pronounced. The DSC data show that the midpoint temperature of spectrin and band 3 membrane domain denaturation transitions is shifted to higher temperatures by 1 to 2ºC. Again the effect is most pronounced for ND and ShC. Redistribution of the spin probe between two microenvironments in EM has been observed. CN universally caused more uniform spreading of the spin probe as compared to control samples.

The effects obtained may result from the reduction of the phospholipid domain attached to protein caused by intensification of protein-protein interactions under the effect of CN or by preferential interaction of CN just with phospholipid protein microenvironment. Such interactions can lead to the stabilization of more rigid protein conformation displaying in higher thermostability and lower molecular mobility. Similar effect of ND and ShC could be connected with specific behaviour of graphene entities of these CN.

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