Detonation Nanodiamond a Possible Instrument for Cancer Theranostics

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The nanodiamonds, synthesized by the detonation (UDD) differ markedly from their well-known classic analogues - natural diamonds or static and dynamic synthesized diamonds. The modification is key step in development of nanodiamond bio-probing and bio-sensing that has specific interaction with bio-object. We are using UDD obtained by detonation of specially mixed explosives in a non-oxidized medium. The obtained nanodiamonds have an average size of 4- 6 nm. The aim of our study was to explore the effects of modified UDD on different cancer cell line. T24-cells obtained from bladder cancer, HeLa –cells obtained from cervical cancer and EA.hy926 –immortalized endothelial cells showed activation of several signal-transduction pathways, following UDD treatment for different time. Several investigations are undergoing to clarify the signalling pathways leading to cell dead. The effects induced by UDD were concentration and time dependent. The modification of nanodiamonds are comparatively new but promising subject of interest for bio-applications, due to their availability in various nano-size, chemical stability, and biocompatibility.

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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Detonation Nanodiamond Slurries for Nucleation of CVD Diamond Films

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The quality of thin polycrystalline CVD diamond films depends heavily on the initial nucleation density, seed size range and distribution uniformity. While explosively formed nanodiamonds are considered an excellant sorce of nuclei for polycrystalline diamond film growth, a perfect seeding solution remains elusive for most CVD diamond growers. To our thinking, the ideal seeding solution is one with diamond particles as small as possible (eg. 4-6 nm size) which do not agglomerate in solution, are held in suspension for indefinite period time, and which can coat a substrate conformally with at least a monolayer of seeds. Such solution should facilitate reproducible deposition of a dense single layer of diamond seeds using a straightforward process.

This study is a part of ongoing effort to improve the seeding technique, with the focus on the seeding solution itself. For testing CVD diamond films were fabricated using the same seeding technique and identical growth conditions, but different seeding solutions: one was DMSO based nanodiamond suspensions, while the other one was an ethanol based. For consistent initial conditions, all silicon substrates underwent the SC-I cleaning procedure. Nanocrystalline diamond films were deposited on quarters of 4”Si and Si/SiO_2 wafers using microwave plasma CVD with the following growth conditions: 750°C, 0.3% CH_4, bal. purified H_2, 15 Torr, 800 Watts. The CVD samples with SiO_2 layer were later tested for pinholes by dipping them in HF. The seeded samples and grown diamond films were analyzed by SEM, some on both the nucleation side (after etching the substrate) and the growth surface. AFM, CV and IV analyses are presented as well. Comparisons between the resulting films are made to quantify the efficacy of the new DMSO-based solution with respect to the better understood ethanol-based suspensions.